Supreme Court, U.S.
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No.

The Supreme Court of the United States

OCTOBER TERM, 1997

GEORGE ARSHAL, Petitioner,

v.

JOHN H. DALTON, Secretary of the Navy.

Petition for a Writ of Certiorari to
The United States Court of Appeals
for the Ninth Circuit

PETITION FOR WRIT OF CERTIORARI

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100 PP

Questions Presented

1. Whether the judgment of the former United States Court of Claims to deprive petitioner of patent rights was unconstitutional and invalid because the court, by the instrumentality of its own judges, committed acts of perjury, libel, fabricated evidence, falsified evidence, disregard of evidence, fraudulent distortions, and flagrant violations of patent law and based its judgment on these very acts.

2. Whether for lack of just compensation, the taking of said patent rights for use by the United States Navy is unconstitutional and is actionable against the Secretary of the Navy because he possesses the use of those rights.

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Opinions Below

The opinion of the Court of Appeals for the Ninth Circuit (Appendix 1, 1a) is reported at 1998 WL 75559. The opinion of the United States District Court for the Western District of Washington, which was issued as an order (Appendix 2, 2a–3a), is unreported. The opinion of the former United States Court of Claims (Appendix 3, 4a–36a) is reported at 621 F.2d 421 (1980). The administrative opinion of the former United States Court of Claims (Appendix 4, 37a–84a) is reported at 202 USPQ 749 (1979).

Grounds for this Court's Jurisdiction

The judgment of the United States Court of Appeals for the Ninth Circuit was entered on February 20, 1998. The jurisdiction of this Court is invoked under 28 U.S.C. § 1254(1).

Constitutional Provisions and Statutes Involved

Constitution, Amendment 5

No person shall be held to answer for a capital, or otherwise infamous crime, unless on a presentment or indictment of a Grand Jury, except in cases arising in the land or naval forces, or in the Militia, when in actual service in time of war or public danger; nor shall any person be subject for the same offence to be twice put in jeopardy of life or limb; nor shall be compelled in any criminal case to be a witness against himself, nor be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use, without just compensation.

Constitution, Amendment 7

In Suits at common law, where the value in controversy shall exceed twenty dollars, the right of trial by jury shall be preserved, and no fact tried by a jury, shall be otherwise reexamined in any Court of the United States, than according to the rules of the common law.

28 U.S.C. § 1331

The district courts shall have original jurisdiction of all civil actions arising under the Constitution, laws, or treaties of the United States.

28 U.S.C. § 1391(e)

A civil action in which a defendant is an officer or employee of the United States or any agency thereof acting in his official capacity or under color of legal authority, or any agency of the United States, or the United States, may, except as otherwise provided by law, be brought in any judicial district in which (1) a defendant in the action resides, (2) a substantial part of the events or omissions giving rise to the claim occurred, or a substantial part of property that is the subject of the action is situated, or (3) the plaintiff resides if no real property is involved in the action. Additional persons may be joined as parties to any such action in accordance with the Federal Rules of Civil Procedure and with such

other venue requirements as would be applicable if the United States or one of its officers, employees, or agencies were not a party.

The summons and complaint in such an action shall be served as provided by the Federal Rules of Civil Procedure except that the delivery of the summons and complaint to the officer or agency as required by the rules may be made by certified mail beyond the territorial limits of the district in which the action is brought.

35 U.S.C. § 101

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

35 U.S.C. § 112

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention. A claim may be written in independent or dependent form, and if in dependent form, it shall be construed to include all the limitations of the claim incorporated by reference into the dependent claim.

An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

Statement of the Case

The Jurisdictional Background

Petitioner received U.S. Patent 3,319,052 (hereinafter called the '052 patent or the '052 invention) on May 9, 1967.[1] The patent describes and claims a "Directional Computer" in various embodiments for use in flight control systems. In 1969, petitioner notified the U.S. Department of the Navy that its Poseidon ballistic missiles infringed on claims 2, 3, 6, and 7 of this patent and pursued an administrative action with the Navy. These negotiations failed and on Dec. 12, 1975, petitioner filed suit in the U.S. Court of Claims (Case No. 431–75, *Arshal v. United States*) to recover compensation for the Government's unauthorized use of the '052 invention. About this time, the infringement of the '052 patent had advanced to the Trident I ballistic missiles of the Navy. In May 1979, the administrative judge[2] hearing the case filed an Opinion on cross motions for summary judgment in which he found that the Poseidon and Trident ballistic missiles infringed on claims 2 and 6 of the '052 patent. He also found, falsely, that the claims were invalid as nonstatutory subject matter, i.e., he found that the claims did not fit within the categories of patentable subject matter said in 35 U.S.C. § 101 which reads:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

The Government did not except to the finding of infringement. The Court of Claims adopted the finding of

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[1] This patent, no. 3,319,052, is attached as Appendix 6 under a separate cover.

[2] The Court of Claims gave the courtesy title of "trial judge" to its adm. judges. These judges have also been called "commissioners."

invalidity under a review in name only, without touching any other question. *Arshal v. United States*, 621 F.2d 421, 423 (1980) (App. 3, 4a–5a).

The present action derives from the extreme violations of law and due process that the Court of Claims used to find the infringed claims invalid. The Constitution absolutely prohibits such deprivation of property. The decision of the Court of Claims was and is invalid. Petitioner's patent rights remained intact.

As a result, the Secretary of the Navy possesses property rights that were taken from petitioner without just compensation, which is unconstitutional conduct. Accordingly, money damages are claimed against him in order to redress the matter. However, the Constitution obligates the Government to pay those damages. Therefore, the suit against the Secretary of the Navy applies as one against an officer acting unconstitutionally under color of legal authority, but it holds him harmless. The suit is "in essence against the United States."

The district courts have jurisdiction nationwide over actions of this kind under the following authorities: Amendment 5 of the Constitution; 28 U.S.C. §§ 1331 and 1391(e); *Davis v. Passman*, 442 U.S. 228, 242; *Stafford v. Briggs*, 444 U.S. 527, n. 6 at 536, 539, 542, n. 10 at 542, 546; *Larson v. Domestic and Foreign Commerce Corp.*, 337 U.S. 682, 696–697; *United States v. Lee*, 106 U.S. 196, 215–218. These authorities include the intent of Congress:

> "By including the officer or employee, both in his official capacity and acting *under color of legal authority* [emphasis added], the committee intends to make the proposed section 1391(e) applicable not only to those cases where an action may be brought against an officer or employee in his official capacity. It intends to include also those cases where the action is nominally brought against the officer in his individual capacity even though he was acting within the apparent scope of his authority and not as a

> private citizen. *Such actions are also in essence against the United States but are brought against the officer or employee as an individual only to circumvent what remains of the doctrine of sovereign immunity* [emphasis supplied]. The considerations of policy which demand that an action against an official may be brought locally rather than in the District of Columbia require similar venue provisions where the action is based upon the fiction that the officer is acting as an individual. . . . ." HR Rep No. 1936, 86th Cong, 2d Sess, 3–4 (1960).

Cited in *Stafford v. Briggs*, 444 U.S. 527, 539 (1980).

The grounds for this action were stated as above in the complaint filed in district court (App. 5, 85a–86a). However, the district court was not at liberty to act under this jurisdiction. It lacks authority to oppose an order of the former Court of Claims which was an appellate court. Its dismissal order disregards the jurisdictional grounds said for this action and is meaningless except as a step towards sending the action to this Court. The same applies to the affirmation of the district court's dismissal by the Court of Appeals for the Ninth Circuit. This Court is necessarily reached for an order to vacate the judgment in *Arshal v. United States*, 621 F.2d 421 (App. 3, 4a–36a), so that the case can proceed in district court.

The Invention at Issue

The '052 invention is used in the flight control systems of missiles or aircraft in the following context:

Flight control systems establish directional control over a kinematic quantity such as the axis of the vehicle or the measured velocity or acceleration of the vehicle. A directional command is supplied and the vehicle is driven to eliminate any directional disparity between the command and the quantity being controlled. To be broadly useful, the command direction must provide a wide range of geometric and rate of change characteristics relative to space. It is through a progression of command

directions that a specifically desired trajectory or other flight condition is produced.

The directional command is often stated relative to space with reference to "a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity." This element is also spoken of as a "stable platform." It typically comprises gyroscopes, gimbals, and control motors. The gyroscopes are fixedly attached to a gimballed reference body; the control motors act on the gimbals to suppress any movement of the reference body indicated by the gyroscopes.

Prior to the '052 invention, the directional command usually referred to the gimbals of a stabilized reference frame and commanded the gimbal angles. The prior art also utilized vehicle fixed gyroscopes and commanded the direction of the vehicle by means of precessing the gyros In either case, the directional command required a flight control response in three degrees of freedom, i.e., in pitch, yaw, and roll. (App. 5, ¶s 4 and 4(a–d), 87a–89a.)

The directional computer (the '052 invention in name) dispenses with angle commands and produces the directional command as a vector. In the infringed claims 2 and 6, the vector is expressed by a set of signals (numbers) referred to the axes of a stabilized reference frame. The axes direct the signals and establish a resultant vector (App. 6, col. 3, lines 14–16).[3]

The directional command is identically the output vector of the directional computer. It is nominally of constant magnitude. It is made to receive a given input vector as its angular velocity relative to space. This forms the process of steering the output vector. The input vector is expressed similarly as the output vector but it takes any magnitude as well as any direction in space.

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[3] As elements of mathematics, vectors are confined to the subject matter of geometry and arithmetic which are the bases of all mathematics. A vector necessarily obtains its directional property from physical geometry.

The input vector completes the concept. It establishes the guidance function and utilizes navigational instruments appropriate to the purpose. It is produced as an ongoing, real-time variable and is severally needed for different guidance functions. The '052 specification teaches basic examples. As variously constructed and selectively used, the input vector generates in the output vector the geometric and rate of change properties relative to space that are required to meet the guidance objectives of any particular phase of flight.

The '052 invention was a breakthrough in the art of flight control. It brought the following advantages to the Poseidon and Trident ballistic missiles:

1. Directional control is accomplished by flight controls in only two degrees of freedom. The ballistic missiles gain in simplification and performance by having to use only a single propulsion nozzle in each stage of boost flight. The single nozzle suffices because it has to support only pitch and yaw control, which it accomplishes by the pitch and yaw deflections available to it. In comparison, prior-art ballistic missiles utilized a heavier and costlier system of multiple nozzles in each stage of propulsion in order to support their additional need of roll control. The multiple nozzles further degraded the missile's performance by diverting a significant amount of missile volume from propellant capacity into extra passageways for the exhaust gases.

2. The appropriate flight control forces are readily and unconditionally defined in the frame of reference of the vehicle. The whole directional control function is executed at once through the shortest route in space and time. The prior-art control systems acting under gimbal-angle commands are far removed from such speed and efficiency of performance, especially when large directional changes are required. They have to develop the gimbal angles in a roundabout, ordered sequence that correlates the control forces of the vehicle and the movement of the gimbals.

3. The stabilized reference frame can have any known orientation relative to the earth. The gimbal-angle controls of prior-art ballistic missiles imposed a downrange alignment on the stabilized reference frame so that the pitch gimbal angle could be positioned to direct the downrange trajectory of the missile. Aligning the stabilized reference frame downrange was time-consuming. It had to be done accurately and it had to be repeated whenever the location either of the target or the submarine was changed. The '052 invention does away with this problem. It enables rapid retargeting under a standard orientation of the stabilized reference frame.

4. Because of improvement no. 2, independently targeted, multiple reentry warheads are deployed about three times faster than previously possible and the store of propellant required to deploy them is much reduced. (App. 5, ¶ 4(e), 89a–90a.)

The Misconduct of the Court of Claims

It is quite apparent that claim 2 qualifies as a claim to a machine and to an improvement of a machine. It categorically meets the standard of statutory (patentable) subject matter. Nor did this fact go unnoticed by the adm. judge of the Court of Claims. In finding infringement, the adm. judge cited the following official documentation (PX-22, NAVORD OP 3557, *Guidance System Poseidon, Mark 3,* Change 2, Rev. 1, p. 3-3):

> 3.2.1 (U) INERTIAL REFERENCE SUBSYSTEM
> The basic function of the inertial reference subsystem, figure 3-4, is to provide a *stable platform* for the acceleration measurement subsystem and to provide a reference platform for missile attitude control. As shown in figure 3-4, the inertial reference subsystem comprises three gyros, three gyro output amplifiers (in one module), a gyro error resolver, three gimbal servo modules, five torque motors, three tachometers, and three gimbals. *The three gyros on the gimbal-mounted stable platform provide error*

> *signals indicating angular displacements of the platform with respect to inertial space.* The error signals are amplified by the gyro output amplifier and the gimbal servo modules and *the amplifier outputs are used to drive the gimbal torque motors to null the platform angular displacement.* (App. 4, 73a–74a.)

The emphasis in this quotation was inserted by the adm. judge. It particularly notes the three constituents of the stabilized reference frame, which are: 1. the physically defined reference frame; 2. the means of sensing the angular motion of the reference frame; and 3. the means of suppressing the angular motion of the reference frame. This recitation unmistakably equates language of claim 2 with machinery. (App. 5, ¶ 20(b), 111a–112a.)

The adm. judge structured his Opinion so that the facts on infringement, such as that recited above from NAVORD OP–3557, *Guidance System Poseidon, Mark 3,* which spoke correctly on the subject matter of claim 2, were nowhere to be seen in his discussion of the claim's validity as to subject matter. Instead, he treated the latter issue under alien recitals of fact and law in which he resorted to perjury, libel, fabricated evidence, falsified evidence, disregard of evidence, fraudulent distortions, and flagrant violations of patent law. These acts were unheard before their appearance in the Opinion of the adm. judge.

These improper acts are well specified in the Complaint (App. 5). They are briefly recapitulated here:[4]

The adm. judge produced a parcel of degenerate lies in order to malign the petitioner and raise false issues. (App. 5, ¶s 13(a–d), 96a–98a.)

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[4] Where the improper acts specified in the Complaint (App. 5) bear original references to the Administrative Opinion of the Court of Claims, the references are restated to their places in the Judgment and/or the Administrative Opinion of the Court of Claims as reproduced in App. 3 and App. 4.

He underrepresented and misrepresented the '052 patent and purported to explain its underlying principles, *using material of his own making.* His real intent was to mislead the reader. The basic fact that direction exists only in connection with a rigid body was unsaid and contradicted, as if some abstract concept of direction sufficed. (App. 5, ¶s 14(a–e), 98a–100a.)

He deliberately misapplied case law, specifically *Gottschalk v. Benson,* 409 U.S. 63. The *Benson* decision disallowed the patenting of "a program only for digital computers." 409 U.S. at 71. It applies at most to a claim of ordinary arithmetic that is not further limited to a process or to machinery or to other technology. (App. 5, ¶ 15(b), 101a, and ¶ 32, 125a–127a.)

He illegally mutilated claim 2 and then subjected it to a fraudulent claim analysis. In a barrage of double-talk, he made the utterly absurd argument that the stabilized reference frame was "insufficient to factually or legally distinguish the claim from the type held to be unpatentable in *Benson.*" He attempted to rationalize this by saying: "all vectors *must* be expressed in terms of a frame of reference and, therefore, a reference frame is also essential to the implementation of the claimed equation," which plainly says that the equation is not mere arithmetic or "a program only for digital computers," and the reference to *Benson* is baseless. (App. 5, ¶s 16(a–d) and 17(a,b), 101a–106a.)

The so-called "claimed equation" is a *statement of geometry.* It describes the directional changes of rigid bodies in rotation. Its scope is immense. One could wholly preempt its use only by laying claim to every rigid body in the universe. The petitioner *and* the defendant (the United States) made this very point in the briefs that were before the adm. judge (App. 5, ¶ 21(b), 113a–114a). Nevertheless, the adm. judge invalidated claim 2 under the criterion that it wholly preempted an equation of the *Benson* kind. (App. 5, ¶ 15(a), 100a, and ¶ 25(a), 116a–117a.)

This conclusion flies in the teeth of the '052 patent itself. The specification and claims of the patent implement the vector equation in both rotating and nonrotating frames of reference. Though functionally identical, these claims are mechanically and computationally distinct and do not preempt each other. (App. 5, ¶s 18(b–d), 106a–110a, and ¶ 27(c), 120a–122a.)

To support his conclusion for the invalidity of claim 2, the adm. judge brazenly altered the documentation of the '052 patent and declared, on his handiwork, that the vector equation cannot be implemented with any kind of reference frame other than a stabilized frame. (App. 5, ¶ 18(b), 106a–108a, and ¶s 27(a–c), 118a–122a.)

He then alleged that petitioner was in *"accord"* with this false statement and he feigned proof of it by referencing a statement of record that said the opposite. (App. 5, ¶s 18(b,d), 106a–108a and 109a–110a.)

His finding of invalidity disregarded the facts of prior art wherein other patented use of the vector equation belied his preemption thesis. (App. 5, ¶ 19, 110a–111a.)

Against this prior art and to buttress the lie that claim 2 wholly preempted an equation, the adm. judge produced the remarkable "fact" that the equation was previously unknown. The assertion was made in total contempt of the facts put before him by the petitioner and the defendant (the United States). (App. 5, ¶s 21(a–d), 113a–114a, and ¶ 26, 117a–118a.)

Petitioner appealed the Opinion of the adm. judge to the higher judges of the Court of Claims only to be rebuffed without even the pretense of a review. It was apparent at the oral argument (Jan. 8, 1980) that no one on the review panel had read the briefs to the appeal and only the presiding judge had read something of the Opinion. All of them exhibited complete hostility toward petitioner, whatever the point of argument. They ratified the Opinion of the adm. judge on its finding of invalidity, then and there. (App. 5, ¶s 29(a–e), 123a–124a.)

After the Court of Claims formally issued its decision (March 19, 1980), petitioner's attorney, who had hitherto been engaged as an adviser, filed motions: (1) for a stay of all proceedings pending this Court's review of *Diamond v. Diehr* (subsequently reported at 450 U.S. 175) and (2) for a rehearing in view of the widespread errors of fact and law tainting the court's decision. The *Diehr* case was taken for review from the Court of Customs and Patent Appeals which adjudged that:

> If the claim is drawn to subject matter, *which is otherwise statutory*, it does not become nonstatutory merely because a computer is involved in its execution. (Emphasis supplied.) *Application of Diehr*, 602 F.2d 982, 985 (Aug. 9, 1979).

This rationale was precisely applicable to petitioner's claim. The stabilized reference frame was a well-patented object for itself alone. (App. 5, ¶ 20(b), 111a–112a.) The misuse of fact and law, which was extensively pointed out, even got support from the defendant (the United States):

> The equation is not new and if this case has to go to trial the defendant is prepared to show by expert testimony that not only is the equation not new but that *a form of the same equation* was used in prior-art missiles. (Emphasis added.)

The court's finding that the patent preempted an equation, which was the whole basis of the court's decision, was bluntly refuted by both parties. But it mattered nothing. The court summarily denied both motions. (App. 5, ¶s 30(a,b), 124a–125a.)

Petitioner next petitioned the Supreme Court for certiorari on the question of "whether a claim to flight control apparatus becomes unpatentable under 35 U.S.C. § 101 because it involves numerical computation" (Case No. 80–437, filed Sept. 19, 1980). The petition was denied. This Court already had the case it wanted in *Diamond v. Diehr* and petitioner's petition was severely handicapped for having to proceed on a record befouled by

official lies and fraud. In the brief in opposition, the defense counsel and higher officials of the Justice Department cited this false matter unsparingly. (App. 5, ¶ 31, 125a.)

After this Court decided *Diehr*, petitioner returned to the Court of Claims and, arguing from this Court's declarations in *Diehr* (see excerpts in App. 5, ¶ 32, 125a–127a) moved for an order to: (1) vacate the judgment entered against petitioner and (2) declare that the '052 claims 2 and 6 are valid under 35 U.S.C. 101. The Court of Claims denied this motion out of hand. (App. 5, ¶ 33, 127a.)

Petitioner's last act in the '052 patent litigation was to file a complaint of judicial misconduct against the adm. judge and all the sitting judges of the Court of Claims, as permitted by 28 U.S.C. § 372(c). Substantially the same assertions of wrongdoing were made then as now. The chief judge of the Court of Claims manipulated the § 372(c) proceeding contrary to its law to make it completely ineffective. Indeed, it was quite coincidental that all the wrongful activity directed against petitioner in the Court of Claims began about the time that the chief judge came to that position from his prior position in the Department of Justice. (App. 5, ¶ 34, 127a–128a.)

The wrongdoing all through the Court of Claims was marked by conspiracy and criminal intent. It was threatened beforehand. The defense counsel for the United States and the administrative judge had previously staged a confidence game against petitioner in a hearing called ostensibly for argument on the cross motions for summary judgment. The adm. judge worked as the confidence man. By way of opposing a meaningless proposition by the defense counsel based on a single element of the patent claim, the adm. judge tried to bait petitioner into endorsing that element as the whole claim.[5] His law clerk intercepted petitioner during the lunch break and urged the endorsement, undoubtedly at

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[5] This claim element is element (c') in p. 16.

the adm. judge's behest. It was sought as a means of "legally" mutilating and invalidating the claim. When allowed to respond to this farce, petitioner immediately disputed the very idea of mutilating the claim. The adm. judge reacted angrily and shouted: "You're only making matters worse for yourself!" At which, the hearing ended. App. 5, ¶s 9(a)–11, 92a–95a, gives specifics.

This open threat to "[make] matters worse" for petitioner clearly revealed the malice of the adm. judge but, as subsequent events showed, the malice had bigger roots. The adm. judge was doing the bidding of the higher judges of the Court of Claims. His brazen performance in the hearing and his even more brazen and vile performance in his Opinion, which the record fully exposes, would have been condemned by any dutiful court. That the adm. judge felt no such concern attests to the complicity of the higher judges. The higher judges for their part held to a conspiracy of silence and obstruction.

Argument

The False Claim Analysis of the Court of Claims

The basic issue is whether the Court of Claims acted unconstitutionally to deprive petitioner of proprietary rights held under claims 2 and 6 of the '052 patent. The Court of Claims declared these patent rights invalid as nonstatutory subject matter under 35 U.S.C. § 101 despite the great reach of § 101 noted by this Court:

> [W]e may not be unmindful of the Committee Reports accompanying the 1952 Act which inform us that Congress intended statutory subject matter to "include anything under the sun that is made by man." *Diamond v. Diehr*, 450 U.S. 175, 182.

Claim 2 is representative of both claims 2 and 6. It reads as follows, as issued, except that the elements of the claim, which are the subject matter of the claim, are broken out and identified as elements (a′), (b′), (c′) for ease of reference:

A directional computer comprising

(a′) a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity,

(b′) means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, and

(c′) means to receive the said input signals and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of the cross product vector between the said output vector and the said input vector,

whereby the said output vector rotates around the said input vector. (App. 6, col. 10.)

Claim 2 utilizes machinery and computation in combination. It is wholly a construction "made by man." It provides an output vector that is steered by an input vector on the model of rotating a rigid body, but with the versatility afforded by freestanding input and output vectors that are readily selected or reset to engage any prepared guidance function when and as needed. It brings superior guidance and equipment efficiencies.

No appeal court of recent times has found a claim of this character to be unpatentable subject matter under 35 U.S.C. § 101 except the United States Court of Claims which did so by means of false and fraudulent representations by its own hand.

The Court of Claims began its mistreatment of claim 2 by altering the claim into a so-called "summarized" version as follows:

(a) a physically defined, stabilized reference frame[13]

(b) means of obtaining input signals defining an input vector in relation to the stabilized reference frame; and

(c) means to calculate $\mathbf{b} = \int (\mathbf{b} \times \mathbf{Y})\, dt$, where **Y** is the input vector, **b** is the output vector, and the integration is relative to the stabilized reference frame.[14]

(App. 3, 17a.)

This is immediately an unlawful act. By 35 U.S.C. § 112, the patent specification and claims are exclusively the province of the inventor/applicant; they may not be tampered with. Also, the claims must be written to the standard of "particularly pointing out and distinctly claiming the subject matter" of the invention. The court violated § 112 on both counts.

The alteration of element (a), which deleted the phrase "having means of sensing and suppressing its angular velocity," was obviously meant to diminish the significance of the true element (a') as machinery. This view is buttressed by the court's reliance on a shallow, flawed discussion of vectors and reference frames of its own making, where the court did its best to give reference frames the look of abstraction. (App. 3, 29a.)

Some basic '052 statements on this subject are:

> The directional computer can be realized in conjunction with a reference frame formed by a physically defined set of three mutually orthogonal directions, providing the component angular velocities (relative to space) of this reference frame are known by measurement or otherwise. (App. 6, col. 4, lines 59–64.)

> [A] reference frame which offers a self-contained capability of expressing its component angular velocities is represented in three rate gyros, the three gyros being rigidly intermounted so that their sensitive axes are mutually orthogonal. The three gyros, as a unit, can be mounted or oriented arbitrarily in any manner desired.
>
> The arbitrarily oriented gyro reference frame is analytically the most general case for instrumenta-

> tional development. It carries the possibility of being constrained to zero values of component angular velocity, either in whole or in part, and also carries the possibility of being controlled into special values of angular velocity. (*Id.* at col. 5, lines 28–40.)

"Space" is inherently the frame of reference of the laws of mechanics. A gyroscope is an instrument that measures angular velocity under the direct action of basic natural law. It measures the angular velocity of its own rigid housing relative to space. It is itself the means of a reference frame. The drawings of the '052 specification illustrate gyro reference frames that are utilized both as a body in arbitrary angular motion and as a gimbal-mounted, motor-driven body under angular control. Such machinery was well known in prior art. The Court of Claims was duty-bound to recognize element (a′) as machinery:

> While the claims of a patent limit the invention, and specifications cannot be utilized to expand the patent monopoly, [cit.], it is fundamental that claims are to be construed in the light of the specifications and both are to be read with a view to ascertaining the invention. *United States v. Adams*, 383 US 39, 48–49; 35 U.S.C. § 112.

Element (b) basically departs from the true element (b′) by crediting the element with "defining an input vector" instead of simply expressing a vector; it is an excessive statement. The input vector is defined by the process of establishing its function. This is accomplished in two distinct stages. Element (c′) is the first part of the process. It is a stationary process; it establishes the input vector as the angular velocity of the output (guidance) vector. At this point, the input vector becomes *defined* as a vector of angular velocity. The second part of the process is a design function. It is concerned with establishing a specific guidance function or a specific class of guidance functions. The input vector is expressly

formulated for the purpose, generally with the aid of navigational instruments. The '052 specification attends to these matters with teaching and examples in col. 2, 3, and 4 (App. 6). The Court of Claims disregarded its duty to recognize this part of the '052 invention.

It is understood from a direct reading of element (c') that it performs arithmetic computations and some bookkeeping. The computations always proceed from known output signals which are entered as a nonzero set to begin with. The output signals are changed continuously at rates of change determined by the cross products between the input and output signals. All the quantities generated, input, output, and intermediate, are referred to the axes of element (a') under a fixed bookkeeping arrangement.

In contrast, element (c) is a fraud. It is in no sense an element or distinct subject matter. It embraces all of claim 2, i.e., all of elements (a'), (b'), and (c') in combination. It pretends "calculation" of all these elements whereas element (a'), which is the claim's basic reference structure, is absolutely impervious to calculation. Calculation is presented only in element (c') where it is an ongoing computation that establishes an ever present steering mechanism. Nothing is calculated in the sense of solving for something.

The Court of Claims purports to examine "whether, under the rationale of *Benson*, [the claims in suit] 'wholly pre-empt the mathematical formula' which they incorporate." (App. 3, 16a.) The court's "analysis" of this issue is based entirely on the false element (c). The immediate consideration must be whether claim 2, or element (c), even falls within the purview of *Benson*.

Benson disallowed patent claims to computer software under the following declarations:

> The claims were not limited to any particular art or technology, to any particular apparatus or machinery, or to any particular end use. 409 U.S. at 64.

> A digital computer, as distinguished from an analog computer, operates on data expressed in digits, solving a problem by doing arithmetic as a person would do it by head and hand. 409 U.S. at 65.
>
> We have, however, made clear from the start that we deal with a program only for digital computers. 409 U.S. at 71.

These declarations constrain the ruling of *Benson* to claims that consist of computer software or equivalent arithmetic and nothing more.

The Court of Claims cites *Benson* as follows:

> The Supreme Court has indicated in *Benson* that a claim should be "limited to [a] particular art or technology, to [a] particular apparatus or machinery, [and] to [a] particular end use." 409 U.S. at 64. (App. 3, 17a.)

This is a brazen misrepresentation of the first of the three declarations of *Benson* cited immediately above. Any one of the stated limitations may qualify a claim as patentable subject matter. The Court of Claims falsely represents them as limitations that must be collectively satisfied by a claim. It then harangues against element (c) for failing to satisfy all the limitations and concludes that: "The element truly does, in the *Benson* sense, wholly preempt the mathematical formula which it embodies." (App. 3, 18a.) Which is totally fraud and nonsense.

The court continues on to say:

> Of course, claim 2 recites more than merely element (c). However, the effect of additional elements (a) and (b) in claim 2 is insufficient to factually or legally distinguish the claim from the type held to be unpatentable in *Benson*. *Id.*

This statement speaks double-talk. Elements (a) and (b) are already incorporated in element (c); they are not "additional." More importantly, the statement is a lie. Element (a) is apparatus comprising gyroscopes, gimbals,

and control motors. To say that element (a) "is insufficient to factually or legally distinguish the claim from the type held to be unpatentable in *Benson*" reaches the height of insanity. Nor was the court free to meddle with the makeup of element (a). Petitioner's initial pleading (Petition) in the Court of Claims states in ¶ 6, first sentence, that: "The stabilized reference frame includes gyroscopes, gimbals, servos and associated electronics." To which the United States answered: "6. First sentence – admitted." The character of the stabilized reference frame was a settled matter from the outset.

The Court of Claims eventually considers element (a) directly and suddenly discovers that element (a) is indeed contained in element (c):

> Because the equation claimed in element (c) operates exclusively on vectors, as we have pointed out in our background mathematics discussion, Appendix B, *infra*, all vectors *must* be expressed in terms of a frame of reference and, therefore, a reference frame is also essential to the implementation of the claimed equation.[15] This is the purpose of element (a) and it too, therefore, is essential to the performance of the computation claimed in element (c). (App. 3, 19a.)

This is a clear admission by the Court of Claims that its reference to *Benson* is baseless. *Benson* applies strictly to claims of computer software. When a claim specifies subject matter of any category said in 35 U.S.C. § 101, such as a machine or *any* useful improvement thereof, it is absolutely patentable under § 101. How much it preempts is irrelevant:

> [A] claim drawn to subject matter otherwise statutory does not become nonstatutory simply because it uses a mathematical formula, computer program, or digital computer. *Diamond v. Diehr*, 450 U.S. 175 at 187.
>
> [W]hen a claim containing a mathematical formula implements or applies that formula in a structure or

process which, when considered as a whole, is performing a function which the patent laws were designed to protect (e.g., transforming or reducing an article to a different state or thing), then the claim satisfies the requirements of § 101. *Id.* at 192.

Furthermore, claim 2 is far removed from wholly preempting an equation. This is demonstrated right in the '052 patent. The patent gives the equation multiple embodiments which are mechanically and arithmetically distinct.

The '052 patent speaks plainly to this matter:

> The directional computer, in all its embodiments, is an implementation of the relationship:
>
> $$\mathbf{b} = \int((A/b^2 - B)\mathbf{b} + \mathbf{b} \times \mathbf{Y})dt \qquad (1)$$
>
> where **b** represents the directional output vector; **Y** represents any given vector or the result of a combination of vectors; A and B represent scalar constants. Under this formulation, **b** is maintained at a constant length, having therefore a purely directional significance, and its direction is controlled with complete versatility by the choice of **Y**. (App. 6, col. 2, lines 1–12.)
>
> The directional computer can be realized in conjunction with a reference frame formed by a physically defined set of three mutually orthogonal directions, providing the component angular velocities (relative to space) of this reference frame are known by measurement or otherwise. Relation (1) is stated for such a reference frame F as
>
> $$\mathbf{b} = \int_F((A/b^2 - B)\mathbf{b} + \mathbf{b} \times \mathbf{Y} + \mathbf{b} \times \omega)dt \qquad (17)$$
>
> where the subscript F on the integral sign identifies F as the reference frame for the integration (the reference frame relative to which the integration proceeds) and ω represents the angular velocity of F. . . . . When the reference frame F is held fixed in space by maintaining its angular velocity ω at zero,

> relation (17) obtains its functionally equivalent form of relation (1). The integral sign, without subscript, in relation (1) is understood to represent integration relative to space. (*Id.* at col. 4, line 59 – col. 5, line 9.)

It is thus said that relation (1) can be realized on the general model of equation (17).

Since the patent claims do not involve the quantity $(A/b^2 - B)\mathbf{b}$ which is unessential, equations (1) and (17) relate to each other and to the claims as

$$\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt = \int_F (\mathbf{b} \times \mathbf{Y} + \mathbf{b} \times \omega) dt.$$

The integral of $\mathbf{b} \times \omega$ in F rotates the output vector **b** relative to F so that it counteracts the rotation of F in space. This integration simply disappears when ω is stabilized at zero. Either way, the remaining integration of $\mathbf{b} \times \mathbf{Y}$ proceeds as one relative to space. $\mathbf{b} \times \mathbf{Y}$ is also integrated relative to space by rotating F so that $\mathbf{b} \times \mathbf{Y} + \mathbf{b} \times \omega = 0$. In this case, the output **b** is represented by an axis of the reference frame. The implementations in rotating frames are described in col. 5, lines 41–70 and col. 7, lines 4–72 (App. 6). They are also illustrated in the drawings. They are claimed by claims 1 and 24. Claim 2 does not preempt either one of them.

The absence of a wholly preempted equation derails the court's agenda to invalidate claim 2 by means of *Benson* which is falsely used anyway. In order to preserve the deception and declare claim 2 invalid, the court resorts to outright perjury. This is seen from the following sequence:

> While it is true that element (a) is limited to a particular type of reference frame, *i.e.*, a "physically defined, stabilized reference frame," the very nature of the claimed equation requires this specific type of reference frame to produce a meaningful result.[16] (App. 3, 19a.)

[16] The claimed equation, $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt$, is but one embodiment of the more general equation $\mathbf{b} = \int ((A/b^2 - B)\mathbf{b} + \mathbf{b} \times \mathbf{Y} + \mathbf{b} \times \omega) dt$, (*see* col. 4, equation (17)) with $A/b^2 - B = \omega = 0$ by definition. To make $\omega = 0$, however, *required* a "physically defined, stabilized reference frame." *See* col. 5, lines 1–7. Thus, the claimed equation cannot be meaningfully implemented with any other type of reference frame. *Accord, see* plaintiff's submission to standard pretrial order on liability (PSPOL), ¶¶ 23, 24 (filed February 27, 1978). (*Ibid.*)

The court seeks to "limit" the equation $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt$ to a stabilized reference frame; it then falsifies the facts to suit. The court first violates equation (17) by stripping the subscript F from the integral sign, which destroys the equality:

$$\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt = \int_F (\mathbf{b} \times \mathbf{Y} + \mathbf{b} \times \omega) dt.$$

The court then concocts the statement: "$A/b^2 - B = \omega = 0$ by definition." No such words may be found anywhere in the record except in the opinion of the court. The court then adds to the falsehood by falsely representing *"Accord"* in ¶s 23 and 24 of plaintiff's submission to the standard pretrial order on liability. ¶ 24 simply defines a space fixed reference frame, i.e., element (a). ¶ 23 reads as follows:

> 23. The need for a space stabilized reference frame or the equivalent information in the form of a physically defined reference frame whose angular velocity relative to space is known arises in connection with the computation of a vector integration or a vector rate of change. Such vector computations are necessarily performed relative to space if they are to be consistent with Newton's laws of motion.

This paragraph clearly says what the '052 patent says: that integration relative to space may be performed in a rotating reference frame whose angular velocity relative

to space is known. The same message is repeated and demonstrated in several more statements to the court including recitations from the file wrapper of the '052 application. See App. 5, ¶s 18(c), 19, 21(b,d), 27(a–d) at 108a–111a, 113a–114a, 118a–122a. The contrary statements of the court are deliberate lies.

Conclusion 1

In plain fact, the Court of Claims willfully applied itself as an instrument of theft. The violations of law and the onslaught of lies permit no other conclusion. The decision of the Court of Claims in *Arshal v. United States*, 621 F.2d 421 (App. 3), is unconstitutional and false.

Conclusion 2

Though formally directed to the United States Court of Appeals for the Ninth Circuit, this petition for certiorari really calls for an examination of the record in *Arshal v. United States*, No. 431–75, in the former United States Court of Claims. The petition should be granted pursuant to this Court's long-standing policy stated in *Napue v. Illinois*, 360 U.S. 264, 271–272 (1959):

> The duty of this Court to make its own independent examination of the record when federal constitutional deprivations are alleged is clear, resting, as it does, on our solemn responsibility for maintaining the Constitution inviolate. Martin v Hunter (US) 1 Wheat 304, 4 L ed 97; Cooper v Aaron, 358 US 1, 3 L ed 2d 5, 78 S Ct 1401. This principle was well stated in Niemotko v Maryland, 340 US 268, 271, 95 L ed 267, 270, 71 S Ct 325, 328:
>
> "In cases in which there is a claim of denial of rights under the Federal Constitution, this Court is not bound by the conclusions of lower courts, but will reexamine the evidentiary basis on which those conclusions are founded."
>
> It is now so well settled that the Court was able to speak in Kern-Limerick Inc. v Scurlock, 347 US 110,

121, 98 L ed 546, 556, 74 S Ct 403, of the "long course of judicial construction which establishes as a principle that the duty rests on this Court to decide for itself facts or constructions upon which federal constitutional issues rest."

Respectfully submitted,

George Arshal, *pro se*
Petitioner

MAY 1998

APPENDIX 1

United States Court of Appeals for the Ninth Circuit

No. 97–35727

GEORGE ARSHAL,
Plaintiff-Appellant,

v.

JOHN H. DALTON, Secretary of the Navy,
Defendant-Appellee.

Appeal from the United States District Court
for the Western District of Washington
District Court No. CV–97–00472–C

February 20, 1998

Before PREGERSON, CANBY, and LEAVY, Circuit Judges.

MEMORANDUM

George Arshal appeals pro se the district court's dismissal of his action alleging that the Secretary of the Navy deprived him of his property rights in a patent. We affirm for the reasons stated in the district court's Order issued on May 29, 1997.

AFFIRMED.

APPENDIX 2

United States District Court
Western District of Washington
At Seattle

NO. C97–472C

GEORGE ARSHAL,

Plaintiff,

v.

JOHN H. DALTON, Secretary of the Navy,

Defendant.

May 29, 1997

ORDER

This matter comes before the Court on the motion of defendant to dismiss plaintiff's action. Having reviewed the pleadings, memoranda, exhibits, and other documents on file, the Court now finds and concludes as follows:

I. Analysis

Plaintiff alleges that the United States deprived him of his property rights in a patent without due process of law. He names John H. Dalton, Secretary of the Navy, as defendant. This is the fifth action he has filed concerning the patent at issue. In the first action, the United States Court of Claims found the patent to be invalid.

Defendants correctly argue that there are a number of grounds that justify dismissal of the present action. First, plaintiff's suit is barred by 28 U.S.C. § 2519 because he is challenging the final judgment of the Court of Claims, which found that his patent was invalid. This statute makes clear that "[a] final judgment of the United States Court of Federal Claims against any plaintiff shall forever bar any further claim, suit, or demand against the

United States arising out of the matters involved in the case or controversy." *Id.*

Second, plaintiff's action is barred by the doctrine of res judicata, which bars all grounds for recovery that were or could have been asserted in a prior suit between the same parties on the same cause of action. *Clark v. Bear Stearns & Co.*, 966 F.2d 1318, 1320 (9th Cir. 1992). Plaintiff is clearly trying to relitigate the patent claims that were denied by the Court of Claims.

Finally, plaintiff's action is defective because the Court lacks subject matter jurisdiction. As found by the Ninth Circuit in plaintiff's two previous, strikingly similar actions, because he is suing a government official in his official capacity this action is essentially against the United States, and because he has not pleaded any express statutory consent to sue, the United States has not waived its sovereign immunity and the Court lacks subject matter jurisdiction. *See Arshal v. Dalton*, 1996 WL 716903 (9th Cir. 1996).

II. Conclusion

The government's motion to dismiss is GRANTED. The Clerk of the Court is directed to enter judgment dismissing this action.

SO ORDERED this 29th day of May, 1997.

/s/_____
John C. Coughenour
United States District Judge

APPENDIX 3

In the United States Court of Claims

No. 431–75

(Decided: March 19, 1980)

GEORGE ARSHAL

v.

THE UNITED STATES

Before KASHIWA, KUNZIG, and BENNETT, *Judges*

ON DEFENDANT'S MOTION AND PLAINTIFF'S CROSS MOTION FOR SUMMARY JUDGMENT

PER CURIAM:

Plaintiff sues the United States for patent infringement, within our jurisdiction under 28 U.S.C. § 1498 (1976). The case is before us on plaintiff's exception to the recommended decision submitted by Trial Judge Browne under Rule 54(a). The trial judge concluded that plaintiff's patent was invalid under 35 U.S.C. § 101 (1976) but denied defendant's motion for patent invalidity under 35 U.S.C. § 103 (1976). He also held that if the patent had been valid, then defendant's actions amounted to infringement. Upon consideration of the briefs and the oral argument of the parties, we agree with the trial judge's conclusion of invalidity under 35 U.S.C. § 101 and to this extent adopt his opinion and conclusion of law as the basis for our judgment in this case. Because of our holding of invalidity under 35 U.S.C. § 101, it is not necessary to render a determination of infringement. For the same reason, we also do not render a determination

as to the correctness of the denial of defendant's motion for patent invalidity under 35 U.S.C. § 103. We have modified the trial judge's opinion, therefore, to delete all references to the 35 U.S.C. § 103 invalidity question and the infringement question. It is, thus, concluded that plaintiff is not entitled to recover, and the petition is dismissed.

The trial judge's report, modified as above indicated and also by certain minor additions and deletions, follows.

OPINION OF TRIAL JUDGE

BROWNE, *Trial Judge*: This action is brought by George Arshal (plaintiff) against the United States (defendant) under the provision of 28 U.S.C. § 1498(a) for recovery of reasonable and entire compensation for the alleged use or manufacture by or for defendant of the invention covered by claims 2, 3, 6, and 7[1] of his United States Patent No. 3,319,052 (the '052 patent), issued May 9, 1967, for a "Directional Computer." The application on which the patent is based was filed January 20, 1966 (Serial No. 533,106) as a continuation of a subsequently abandoned application (Serial No. 206,801) filed July 2, 1962.

Defendant moved for summary judgment on March 30, 1978, on the issue of validity, and plaintiff moved for summary judgment on April 7, 1978, on the issues of validity, infringement, and license. The court referred the motions to the trial judge on July 25, 1978, pursuant to Rule 54 for his opinion and recommendation for the conclusion of law.

Upon review of the motions, supporting briefs, and extensive oral arguments of both parties heard on February 7 and 8, 1979, we have concluded that the '052 patent is invalid; wherefore, plaintiff is not entitled to recover on his claim for reasonable and entire

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[1] The text of the asserted claims is set forth in Appendix A, *infra*.

compensation. Accordingly, defendant's motion for summary judgment is granted and plaintiff's motion for summary judgment on the issue of validity is denied. Since holding the patent to be invalid makes moot the issues of infringement and license, these two issues are not considered. The holding of invalidity also being dispositive of the case, the petition is dismissed.

I. *The Pleadings*

Plaintiff filed his petition, *pro se*, on December 12, 1975, after having failed to negotiate an administrative settlement of his claim with the Department of the Navy. In his petition, plaintiff alleges that claims 2, 3, 6, and 7 of his patent are infringed by the guidance system manufactured for and used by defendant in its Poseidon missile, and also by the guidance system intended for use in the Trident C4 (Trident) missile. Lockheed Missiles and Space Company, Inc., of Sunnyvale, California (Lockheed) is alleged to be the sole manufacturer of the missiles for defendant.

Defendant filed its answer to the petition on April 9, 1976. In its answer defendant admitted that the Poseidon missiles were supplied by Lockheed and used by defendant, and that certain plans exist with respect to manufacture and use of the Trident C4 missile by defendant. Defendant denied, however, that the patent has been infringed or that it was duly and legally issued, or otherwise enforceable. Defendant contends that, in any event, it is licensed under the patent in suit.

II. *The Patent in Suit*

In order to comprehend the legal issues of this case, it is necessary first to have a basic understanding of the underlying mathematics of the invention, since it involves vectors, vector algebra, and vector calculus. A very brief discussion of these concepts is presented in Appendix B of this opinion. The discussion which follows presumes both a basic knowledge of elementary algebra and an

understanding of the appended discussion of vector mathematics.

The '052 patent is entitled, "Directional Computer." It defines the invention as "a vectorial data processing system for extracting or prescribing directions and their rates of change from given input vectors." The patent specification specifically states that the output direction is affected by the input vector in one or both of the following two ways:

(1) So that the output direction rotates around the input vector to describe a conical surface.

(2) So that the output direction rotates directly towards the input vector and seeks coalignment.

The system is described as useful in aircraft flight control, as one example. It is also intended for use to "service demanding applications requiring wide ranging directional controls under a variety of options." The remaining portion of the specification describes the invention primarily in terms of vector algebra. The drawings illustrate examples of the relationship of the algebraic expressions disclosed in the specification in terms of circuit diagrams and other graphic symbols.

III. *Validity of the Claims Under 35 U.S.C. § 101*

A. *The Positions of the Parties*

Defendant has alleged in its motion for summary judgment that claims 2, 3, 6, and 7 of the patent are invalid because they are drawn to subject matter which is not patentable under the Patent Act of 1952 (Title 35, United States Code). Specifically, defendant contends that the claims, essentially, are drawn to a mathematical equation, and that a mathematical equation is not patentable subject matter under 35 U.S.C. § 101.[2]

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[2] 35 U.S.C. § 101 states: "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may

Claim 2 of the patent is illustrative of all of the claims in suit and states:[3]

> 2. A directional computer comprising
>
> (a) a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity,
>
> (b) means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, and
>
> (c) means to receive the said input signals and generate a plurality of output signals *expressing an output vector in relation to said reference frame as the integral of the cross product vector between the said output vector and the said input vector*, whereby the said output vector rotates around the said input vector. [Emphasis added.]

To support its position that claim 2 is essentially directed to a mathematical equation, defendant points to the italicized phrase in part (c) of claim 2. (This language also appears in the remaining claims in suit, namely, claims 3, 6, and 7). Although plaintiff does not dispute that this language is the verbal equivalent of a mathematical expression,[4] plaintiff points out that this language forms only a portion of the claim and that, when

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obtain a patent therefor, subject to the conditions and requirements of this title."

[3] The claim has been broken down into three parts for analytical purposes. It does not appear in this format in the patent.

[4] Specifically, the language recites the mathematical expression $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt$, where **Y** represents a desired input vector and **b** represents a directional output vector.

considered in its entirety, the claim is not directed to an equation, but to a *machine*.

B. *The Applicable Law*

Since mathematical expressions or equations, *per se*, are not susceptible to patent protection under section 101 of the Patent Act,[5] we must determine whether or not the asserted claims define an invention which is merely a mathematical expression or equation. If the mathematical expression or equation is simply an adjunct to the invention sought to be covered, the inclusion thereof in the claims is not fatal to their validity. If, however, the invention itself can be expressed only in terms of the mathematical expression or equation, it is outside the scope of 35 U.S.C. § 101 and, therefore, is invalid under the applicable case law.

Tests for determining whether a claim is directed to subject matter which is not patentable have been applied in some cases which predated the 1952 Patent Act, and many others subsequent to that Act. In some early cases, because the "point of novelty" or truly novel element in the claims was determined to be a mathematical expression or equation, the claims were held to be nonstatutory.[6] *See e.g., In re Abrams*, 188 F.2d 165, 38 CCPA 945, 89 USPQ 266 (1951).

The "point of novelty" test was, at first, followed after the effective date of the 1952 Act, but was formally rejected by the Court of Customs and Patent Appeals

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[5] Section 101 of the Patent Act, *see* fn. 2, *supra*, does not expressly *exclude* a mathematical expression or equation as patentable subject matter. Case law, however, has established that they are not included. *See e.g., Gottschalk v. Benson*, 409 U.S. 63, 175 USPQ 673 (1972); *Mackay Radio & Telegraph Co. v. Radio Corporation of America*, 306 U.S. 86, 40 USPQ 199 (1938).

[6] The word "nonstatutory" is sometimes used to apply to a claim directed to subject matter which is not expressly entitled to patent protection.

(CCPA) in *In re Bernhart*,[7] 417 F.2d 1395, 57 CCPA 737, 163 USPQ 611 (1969).[8] In *Bernhart*, among the claims before that court was an apparatus claim directed to a general purpose computer programmed to calculate the results of a complex mathematical equation. In reversing the Examiner's rejection of this claim (which was based upon the Examiner's belief that the novelty of the claim lay in the equations with which the computer was programmed), the court stated:

> The principle [behind the Examiner's rejection] may, we think, be fairly stated as follows: If, in an invention defined by a claim, the novelty is indicated by an expression which does not itself fit in a statutory class (in this case not a machine or a part thereof), then the whole invention is nonstatutory since all else in the claim is old. We do not believe this view is correct under the Patent Act and the case law thus far developed. [*Id.* at 1399, 57 CCPA at 743. 163 USPQ at 615–16.]

Instead, the court concluded that:

> [I]f a machine is programmed in a certain new and unobvious way, it is physically different from the machine without that program; its memory elements are differently arranged. The fact that these physical changes are invisible to the eye should not tempt us

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[7] As a point of fact, the CCPA first rejected this approach in *In re Prater*, 415 F.2d 1378, 159 USPQ 583 (CCPA 1968). However, the opinion in *Prater* was subsequently vacated, 415 F.2d 1378, 160 USPQ 230, and replaced by an opinion which did not discuss the propriety of the "point of novelty" test, *see* 415 F.2d 1393, 56 CCPA 1381, 162 USPQ 541 (1969).

[8] The decisions of the Court of Customs and Patent Appeals, while being neither controlling nor binding on this court, are nevertheless accorded great weight and respect in view of the manifest expertise of that court in determining whether or not claims presented in pending applications for patents satisfy the requirements of the patent statutes.

> to conclude that the machine has not been changed. If a new machine has not been invented, certainly a "new and useful improvement" of the unprogrammed machine has been, and Congress has said in 35 U.S.C. § 101 that such improvements are statutory subject matter for a patent. [*Id.* at 1400, 57 CCPA at 744, 163 USPQ at 616.]

The CCPA reaffirmed its rejection of the "point of novelty" test in *In re Musgrave*, 431 F.2d 882, 57 CCPA 1352, 167 USPQ 280 (1970), and pointed out the fallacy in that test:

> [I]t is our view that [the point of novelty test is] logically unsound. According to [this test], a process containing both "physical steps" [the statutory portion] and so-called "mental steps" [the nonstatutory portion] constitutes statutory subject matter if the "alleged novelty or advancement in the art resides in" steps deemed to be "physical" and nonstatutory if it resides in steps deemed to be "mental". It should be apparent, however, that novelty and advancement of an art are irrelevant to a determination of whether the nature of a process is such that it is encompassed by the meaning of "process" in 35 U.S.C. § 101. Were that not so, as it would not be if [the point of novelty test] were the law, a given process including both "physical" and "mental" steps could be statutory during the infancy of the field of technology to which it pertained, when the physical steps were new, and nonstatutory at some later time after the physical steps became old, acquiring prior art status, which would be an absurd result. Logically, the identical process cannot be first within and later without the categories of statutory subject matter, depending on such extraneous factors. [*Id.* at 889, 57 CCPA at 1362, 167 USPQ at 286–87.]

Instead, the court stated that all that was needed to make the claimed process statutory under 35 U.S.C. § 101 was

"that it be in the technological arts so as to be in consonance with the Constitutional purpose to promote the progress of 'useful arts'." 431 F.2d at 893, 57 CCPA at 1367, 167 USPQ at 289–90. Finding the claims at issue to be within the technological arts, the court reversed the examiner's rejection.

The new "technological arts" test was reaffirmed by the CCPA in *In re Foster*, 438 F.2d 1011, 58 CCPA 1001, 169 USPQ 99 (1971), as it stated that "it is not important whether the claims contain mental steps [the nonstatutory portion] or not if the process is within the technological arts." *Id.* at 1015, 58 CCPA at 1004, 169 USPQ at 101. And in *In re Waldman*, 457 F.2d 997, 59 CCPA 940, 173 USPQ 430 (1972), *aff'd*, 559 F.2d 611, 194 USPQ 465 (Cust. & Pat. App. 1977) the CCPA explained that "[t]he phrase 'technological arts,' as we have used it, is synonymous with the phrase 'useful arts' as it appears in Article I, Section 8 of the Constitution." *Id.* at 1003, 59 CCPA at 947, 173 USPQ at 434.

In *In re Benson*, 441 F.2d 682, 58 CCPA 1134, 169 USPQ 548 (1971), the CCPA again applied their "technological arts" test to reverse a section 101 rejection of a claim drawn to a method of converting one form of numerical representation into another, utilizing a novel algorithm. After concluding that the process had no practical use except in connection with a digital computer, the court stated:

> It seems beyond question that the machines—the computers—are in the technological field, are a part of one of our best-known technologies, and are in the "useful arts" rather than the "liberal arts," as are all other types of "business machines," regardless of the uses to which their users may put them. How can it be said that a process having no practical value other than enhancing the internal operation of those machines is not likewise in the technological or useful arts? We conclude that the Patent Office has put forth no sound reason why the claims in this case

should be held to be nonstatutory. [*Id.* at 688, 58 CCPA at 1143, 169 USPQ at 553.]

Certiorari was granted in *Benson*, and the Supreme Court, however, *reversed*. *Gottschalk v. Benson*, 409 U.S. 63, 93 S.Ct. 253, 34 L.Ed.2d 273, 175 USPQ 673 (1972).[9] The Supreme Court began by pointing out that the case law has well established the principle that one may not patent an *idea*. Directing its attention to the *claims* at issue, the Court found two fatal objections to their validity: first, that "[t]he claims were not limited to any particular art or technology, to any particular apparatus or machinery, or to any particular end use," *id.* at 64, 93 S.Ct. at 254, 175 USPQ at 674, but were "so abstract and sweeping as to cover both known and unknown uses" of the *claimed* invention, *id.* at 68, 93 S.Ct. at 255, 175 USPQ 675; and second, that because the mathematical formula embodied in the *claims* had "no substantial practical application except in connection with a digital computer, . . . the patent [claims] would wholly preempt the mathematical formula and in practical effect would be a patent on the algorithm itself." *Id.* at 71–72, 93 S.Ct. at 257, 175 USPQ at 676.

The determination of whether a *claim* preempts nonstatutory subject matter under the rationale of *Benson* has been determined to require a two-step analysis:

> First, it must be determined whether the claim directly or indirectly recites an "algorithm" in the *Benson* sense of that term, for a claim which fails even to recite an algorithm clearly cannot wholly preempt an algorithm. Second, the claim must be further analyzed to ascertain whether in its entirety it wholly preempts that algorithm. [*In re Freeman*,

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[9] All subsequent references to "*Benson*" are to *Gottschalk v. Benson*, 409 U.S. 63, 93 S.Ct. 253, 34 L.Ed.2d 273, 175 USPQ 673 (1972).

573 F.2d 1237, 1245, 197 USPQ 464, 471 (Cust. & Pat. App. 1978).]

We now direct our attention to that analysis.

Plaintiff contends that his claims do not recite an "algorithm" in the *Benson* sense, but are directed to "physical geometry." Specifically, plaintiff states that his claims are distinguishable from those in *Benson* because his are "concerned with creating a circumstance," while those in *Benson* are concerned with "determining the value of a variable that already exists in the context of a specific set of circumstances." We find, however, this distinction, if it is one at all, to be of no consequence. The important point is that the claims both in *Benson* and in this suit are directed to a particular means for transforming defined input signals into useful output signals. Although *Benson* did not render all algorithms (as defined by the dictionary) to be nonstatutory, subsequent case law has clearly established that a formula or equation, even if expressed in its prose equivalent, is the type of subject matter to which the *Benson* rationale must be applied. *See In re Freeman*, 573 F.2d at 1246, 197 USPQ at 471 (and cases cited therein).

Plaintiff further argues that *Benson* is inapplicable because the claims in *Benson* are drafted in the form of a "method," whereas the claims in this suit are drafted in the form of an "apparatus" (using "means plus function" language).[10] However, even the language used in *Benson* itself indicates that the fundamental principles governing the statutory determination of "method" claims are equally applicable to "apparatus" claims:

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[10] It should be noted that plaintiff, who prosecuted his patent application *pro se*, did not have the benefit of the CCPA and Supreme Court decisions rendered after May 9, 1967, since the patent issued on that date was based on his application which was first filed in 1962 and refiled in 1966. *In re Abrams*, *supra*, was the only significant precedent available during the pendency of plaintiff's applications.

> As we stated in *Funk Bros. Seed Co. v. Kalo Co.*, 333 U.S. 127, 130, 68 S.Ct. 440, 441, 92 L.Ed. 588, "He who discovers a hitherto unknown phenomenon of nature has no claim to a monopoly of it which the law recognizes. If there is to be invention from such a discovery, it must come from the application of the law of nature to a new and useful end." *We dealt there with a "product" claim, while the present case deals with a "process" claim. But we think the same principle applies.* [409 U.S. at 67–68, 93 S.Ct. at 255, 175 USPQ at 675 (citations omitted and emphasis added)].

As the CCPA stated in *In re Freeman*, it is not the form of the claim which is controlling but its substance:

> Though a claim expressed in "means for" (functional) terms is said to be an apparatus claim, the subject matter as a whole of that claim may be indistinguishable from that of a method claim drawn to the steps performed by the "means" . . . . [I]f allowance of a method claim is proscribed by *Benson*, it would be anomalous to grant a claim to apparatus encompassing any and every "means for" practicing that very method. [573 F.2d at 1247, 197 USPQ at 472 (footnote omitted)].

To do otherwise would make the determination of patentable subject matter depend simply on the draftsman's skill which would ill serve the principles underlying the prohibition against patents for ideas. *See Parker v. Flook*, 437 U.S. 584, 593, 98 S.Ct. 2522, 2527, 57 L.Ed.2d 451, 198 USPQ 193, 198 (1978).

Plaintiff finally urges that *Benson* is inapplicable because *Benson* dealt with an algorithm used only in digital computers, whereas plaintiff's patent discloses his equation for use in analog computers. While it is true that the Supreme Court in *Benson* expressly declined to extend its holding to algorithms used in analog

computers,[11] it is also true that they did not in any way disapprove of such an extension. As we can see no factual reason for making such a legal distinction, we believe that the rationale of *Benson* is equally applicable to algorithms used in analog computers. This conclusion, however, is unnecessary to our decision as the claims in suit are in no way limited to analog computers. That the specification may disclose analog computers in one embodiment of the claimed invention is irrelevant. Although the specification may be properly used to *interpret* limitations already present in the claims, *Westwood Chemicals, Inc. v. United States*, 207 Ct. Cl. 791, 525 F.2d 1367, 187 USPQ 656 (1975), the specification may never be used to *add* additional and otherwise nonexistent limitations to those claims, *Siegel v. Watson*, 105 U.S.App.D.C. 344, 267 F.2d 621, 121 USPQ 119 (D.C. Cir. 1959). To be sure, not even plaintiff seriously contends that his claims do not encompass digital computers for plaintiff, himself, contends that defendant's alleged infringing computer, which is a digital computer, is fully encompassed by his patent claims. It is a fundamental principle of patent law that a claim may not be narrowly construed to avoid invalidity and then broadly construed to encompass the accused device. *See e.g., Dominion Magnesium Ltd. v. United States*, 162 Ct. Cl. 240, 320 F.2d 388, 138 USPQ 306 (1963).

Accordingly, the rationale of *Benson* is applicable to a determination of validity of the claims in this case. The issue to which we now direct our attention is whether, under the rationale of *Benson*, these claims "wholly preempt the mathematical formula" which they incorporate.

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[11] Specifically, the Court stated: "It is said that we have before us a program for a digital computer but extend our holding to programs for analog computers. We have, however, made clear from the start that we deal with a program only for digital computers." 409 U.S. at 71, 93 S.Ct. at 257, 175 USPQ at 676.

C. *Application of the Law to the Claims*

1. Claim 2[12]

Claim 2 recites three elements which can, functionally, be summarized as follows:

(a) a physically defined, stabilized reference frame[13]

(b) means of obtaining input signals defining an input vector in relation to the stabilized reference frame; and

(c) means to calculate $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt$, where $\mathbf{Y}$ is the input vector, $\mathbf{b}$ is the output vector, and the integration is relative to the stabilized reference frame.[14]

The Supreme Court has indicated in *Benson* that a claim should be "limited to [a] particular art or technology, to [a] particular apparatus or machinery, [and] to [a] particular end use." 409 U.S. at 64, 93 S.Ct. at 254,

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[12] For the full text of claim 2, see Appendix A, *infra*.

[13] This element is further described in the claim as "having means of sensing and suppressing its angular velocity." However, it is clear from the specification that this language merely clarifies the essential nature of a "stabilized reference frame" and thus is without limiting effect. *See* col. 5, lines 4–9. To be sure, plaintiff wholly agrees with this conclusion.

[14] This element is further described in the claim by the language "whereby the said output vector rotates around the said input vector." However, this language has no limiting effect for it is clear that in every implementation of the claimed equation the "output vector rotates around the said input vector" whether it rotates to trace a conical surface around the input vector or seeks coalignment with it.

The statement that "the integration is relative to the stabilized reference frame" is used to mean what the inventor in his specifications has defined it to mean, namely that the vector quantities of the integrand, *i.e.*, $\mathbf{b}$ and $\mathbf{Y}$ are expressed in reference to the stabilized reference frame. *See* cols. 4 and 5, lines 64–75 and 1–4, respectively.

175 USPQ at 674. If we consider only element (c) of claim 2 for the moment, it is clear that it violates each and every requirement of this rule. First, it in no way specifies any use for the calculated output vector and, therefore, is not "limited to any particular end use." Second, the "means plus function" language encompasses any and every type of apparatus or machine which could be used to implement the claimed equation and, therefore, the element is not "limited to any particular apparatus or machinery." Finally, the element has application in arts or technologies as diverse as the equation itself and, therefore, is not "limited to any particular art or technology." The element truly does, in the *Benson* sense, wholly preempt the mathematical formula which it embodies.

Of course, claim 2 recites more than merely element (c). However, the effect of additional elements (a) and (b) in claim 2 is insufficient to factually or legally distinguish the claim from the type held to be unpatentable in *Benson*. The reason for this conclusion becomes clear upon an understanding of the purpose of these elements.

As we have stated above, element (c) merely calls for means to perform a mathematical computation which, by itself, is unpatentable subject matter. Because the equation recited in element (c) is a calculation using an input vector, *i.e.*, **Y**, apparatus performing that calculation necessarily requires means to generate the value of the input vector, **Y**. Element (b) is for just that purpose and, therefore, is essential to the performance of the computation. Thus, the "limitation" in the claim effectuated by the addition of element (b) is, for all practical purposes, not a limitation at all because element (c) cannot function in the absence of element (b). Of course, if element (b) recited apparatus which generated a *particular* type of input signal, such as a specified physical quantity, our conclusion might be different. But it does not, and, in fact, it states that the input signals

defining the input vector may be representative of "any desired value."

The same is true of element (a). Because the equation claimed in element (c) operates exclusively on vectors, as we have pointed out in our background mathematics discussion, Appendix B, *infra*, all vectors *must* be expressed in terms of a frame of reference and, therefore, a reference frame is also essential to the implementation of the claimed equation.[15] This is the purpose of element (a) and it too, therefore, is essential to the performance of the computation claimed in element (c). While it is true that element (a) is limited to a particular type of reference frame, *i.e.*, a "physically defined, stabilized reference frame," the very nature of the claimed equation requires this specific type of reference frame to produce a meaningful result.[16]

In *In re Christenson*, 478 F.2d 1392, 178 USPQ 35 (Cust. & Pat. App. 1973), the CCPA was presented with a similar case. The claim at issue contained a mathematical equation and several "data gathering" steps. In rejecting the contention that the addition of "data gathering" steps could convert a nonstatutory claim into statutory subject matter, the court said:

> Given that the *method of solving* a mathematical equation may not be the subject of patent protection,

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[15] Plaintiff wholly agrees with this statement. *See* n. 25, *infra*.

[16] The claimed equation, $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} \, dt$, is but one embodiment of the more general equation $\mathbf{b} = \int ((A/b^2 - B)\mathbf{b} + \mathbf{b} \times \mathbf{Y} + \mathbf{b} \times \omega) \, dt$, (*see* col. 4, equation (17)) with $A/b^2 - B = \omega = 0$ by definition. To make $\omega = 0$, however, *required* a "physically defined, stabilized reference frame." *See* col. 5, lines 1–7. Thus, the claimed equation cannot be meaningfully implemented with any other type of reference frame. *Accord, see* plaintiff's submission to the standard pretrial order on liability (PSPOL), ¶¶ 23, 24 (filed February 27, 1978).

> it follows that the addition of the old and necessary antecedent *steps of establishing values for the variables in the equation* cannot convert the unpatentable method to patentable subject matter. [*Id.*, at 1394, 178 USPQ at 37–38 (emphasis supplied)].

The rationale behind this pronouncement of law was later explained by Chief Judge Markey in *In re Sarkar*, 588 F.2d 1330, 200 USPQ 132 (Cust. & Pat. App. 1978):

> No mathematical equation can be used, as a practical matter, without establishing and substituting values for the variables expressed therein. Substitution of values dictated by the formula has thus been viewed as a form of mathematical step. If the steps of gathering and substituting values were alone sufficient, every mathematical equation, formula, or algorithm having any practical use would be per se subject to patenting as a "process" under § 101. [*Id.*, at 1335, 200 USPQ at 139.]

Even where the antecedent "data gathering" steps are novel and unobvious, their recitation in combination with a mathematical computing step is legally insufficient to give rise to a patentable claim under § 101 of the Patent Act. *In re Richman*, 563 F.2d 1026, 195 USPQ 340 (Cust. & Pat. App. 1977); *accord*, *In re Sarkar*, *supra*, at 1336 n. 18, 200 USPQ at 139 n. 18.

Of course, these CCPA precedents dealt with claimed *processes*, not *apparatus*. However, as we have already pointed out, the controlling principles are the same. Otherwise, the anomaly might result that a claim to apparatus encompassing any and every means for performing a method might be valid while, at the same time, a claim encompassing all methods of obtaining the desired result might be proscribed by *Benson*. *In re Freeman*, 573 F.2d at 1247, 197 USPQ at 472.

Plaintiff maintains, however, that claim 2 does not preempt a mathematical equation because the preamble "[a] directional computer" adequately limits the scope of

the claim to a particular technology, *i.e.*, the directional computer technology. We find as a matter of law, however, that those words do not effectively limit the claim to any *particular* technology.[17]

First of all, computers are applicable to all technologies, not to any *particular* technology. Although the type of computer is specified as a "directional" computer, in the present case, this is a limitation without substance because vector computations (the type of computation recited in the claim), by definition, include directional computations. Thus, the claimed mathematical formula already intrinsically calls for directional computations and, therefore, use of the word "directional" in the preamble creates no additional limitation.

Second, there is a substantial question whether words in a preamble which do not appear in the body of the claim may even properly be used to limit the scope of the claim. *See e.g., Strador v. Watson*, 100 U.S.App.D.C. 289, 244 F.2d 737, 113 USPQ 365 (D.C. Cir. 1957). Where, as here, the effect of the words are at best ambiguous (*i.e.*, as pointed out above, there is uncertainty whether the words have any limiting effect on the scope of the claim), a compelling reason must exist before the language can be given weight. *Cf. In re de Castelet*, 562 F.2d 1236, 1244, n. 6, 195 USPQ 439, 447, n. 6 (Cust. & Pat. App. 1977) (Where there is a potential for misconstruction of preamble language, a compelling reason must exist before the language can be given weight.) We can see no such reason in this case, for the language in the body of claim 2, standing alone, is clear and unambiguous.

Even assuming, *arguendo*, that the preamble language "[a] directional computer" does have the effect of limiting the scope of claim 2 to a particular technology,

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[17] While the specification describes the invention as being a "vectorial data processing system" which is useful in "aircraft flight control," all of the claims are directed to a "directional computer," without recitation or limitation as to *any* field of use.

the fact remains that claim 2 still preempts a mathematical equation, albeit in a limited and specific application. As the CCPA established in *In re Waldbaum*, 559 F.2d 611, 194 USPQ 465 (Cust. & Pat. App. 1977), preemption of a mathematical calculation is fatal to the validity of a claim regardless of the scope of that preemption:

> [C]laims 1, 2 and 19 do not represent "no less of a 'computer processing program' than did claim 8 in *Benson*," because they are limited to the specific application of calculating the number of busy and idle lines in a telephone system. They would not preempt all uses of the algorithm [citing uses of the algorithm outside of the claimed invention], but would preempt only use of the algorithm in calculating the number of busy and idle lines in a telephone system. At the same time, it must be recognized that a patent on these claims would, in practical effect, be a patent on the algorithm itself—albeit in its limited, specific application to *calculating* the number of busy and idle lines in a telephone system. . . . .
>
> In view of the foregoing, we hold that claims 1, 2 and 19 do not define a statutory process within the meaning of 35 U.S.C. §§ 100 and 101. [*Id.* at 617, 194 USPQ at 469–70 (footnotes omitted)].

Similarly, the Supreme Court recently held in *Parker v. Flook*, 437 U.S. 584, 595 n. 18, 98 S.Ct. 2522, 2528 n. 18, 57 L.Ed.2d 451, 198 USPQ 193, 199 n. 18 (1978), that "a claim for an improved method of calculation, even when tied to a specific end use, is unpatentable subject matter under § 101."

It is important to point out that a claim is not invalid merely because it recites a mathematical equation or computation. *Parker v. Flook, supra.* Rather, a claim reciting a mathematical equation or computation as one of its elements will be invalid only if, when considered in its entirety, the essence of the claim is nothing more than that element. Although the line of demarcation between a

patentable and an unpatentable (or non-patentable) claim does not always shimmer with clarity, a persuasive index of a valid mathematical-calculating type of claim is when the claimed computation or equation is used not merely to calculate a numerical value, but is used to effectuate a physical result. For example, the CCPA recently held a series of claims directed to methods for removing unwanted noise from seismic data not to be invalid under § 101 because the purpose of the claimed invention was to "filter out extraneous and erroneous components and to physically record a noiseless seismic trace on a record medium," rather than to merely "compute a new value." *In re Johnson*, 589 F.2d 1070, 200 USPQ 199 (Cust. & Pat. App. 1978). As is apparent from a reading of claim 2 of the patent in suit, however, the sole purpose of the invention recited therein is merely to "compute a new value." Thus, for this reason and all of the reasons discussed above, we conclude that, under the rationale of *Benson* and its progeny, unlike the claims in *Johnson*, claim 2 is invalid.

2. *Claim 6*[18]

We find the additional language placed in the remaining claims in suit insufficient to distinguish them from nonstatutory claim 2, as a matter of law. With respect to claim 6, the parties agree that it differs from claim 2 in that it calls for the following additional elements:

(d) a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation there between,

(e) the input signals being referred to the second reference frame to express an input vector, and

(f) the "means" receiving the input signals and generating the output signals to include the coordinate transformation means in (d) above.

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[18] The full text of claim 6 is recited in Appendix A, *infra*.

See PRDRFA at ¶ 21. The essential difference between claim 6 and nonstatutory claim 2, therefore, is that claim 6 calls for an *additional* data gathering element, the "second reference frame," and for an additional mathematical calculating element, the "means to perform a coordinate transformation."[19] Certainly, the addition of a second mathematical calculating element (an element which is on its face nonstatutory), cannot change a nonstatutory claim into one which is statutory; and we think that, given the principle that the addition of a "data gathering" element cannot change an otherwise nonstatutory claim into a statutory claim, the inclusion of an *additional* "data gathering" element in the claim will also not have that effect. Accordingly, we conclude that claim 6 does not define an invention which is entitled to patent protection under 35 U.S.C. § 101. We now consider the effect of the differences between claim 3 and claim 2.

3. *Claim 3*[20]

When the value of the output vector, **b**, recited in claim 2 is computed, as we have explained in the mathematical background discussion, *infra* at Appendix B, what is actually computed is the scalar values of the output vector's three projections on the axes of a cartesian coordinate reference frame, *i.e.*, b_1, b_2, and b_3. Thus, while claim 2 recites only a single mathematical equation, *i.e.*, $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt$, the solution of that equation requires the following three separate computations (a fact not disputed by the parties):[21]

$$b_1 = \int (b_2 Y_3 - b_3 Y_2)\, dt;$$

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[19] The specifications disclose that the "means to perform a coordinate transformation" is merely apparatus which performs a series of known mathematical computations. *See* cols. 6 and 7, lines 15–17 and 1–3, respectively.

[20] The full text of claim 3 is presented in Appendix A, *infra*.

[21] The derivation of these equations is shown in the background mathematics discussion *infra* at Appendix B.

$$b_2 = \int (b_3 Y_1 - b_1 Y_3)\, dt; \text{ and}$$
$$b_3 = \int (b_1 Y_2 - b_2 Y_1)\, dt.$$

Claim 3, on the other hand, expressly limits its scope by defining only the third axis projection (Y_3) with respect to the reference frame. Unlike claim 2, the remaining projections of the input vector (*i.e.*, Y_2 and Y_1) are not expressly defined. Also, unlike claim 2, only *two* of the projections of the output vector are calculated (b_1 and b_2),[22] rather than the full set (b_1, b_2, and b_3) calculated by the apparatus recited in claim 2. Based upon this analysis (the accuracy of which is not disputed), the only difference between claim 3 and claim 2 is that claim 3 calls for apparatus which performs only *two* computations, while claim 2 intrinsically calls for apparatus which performs *three* computations. This difference, however, does not make claim 3 any less "abstract" or "sweeping" in the *Benson* sense than claim 2. It merely alters the quantity and perhaps the substance[23] of the computations

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[22] The parties dispute the implication to be drawn from the failure of the claim to expressly define the value of two of the three projections of the input vector (*i.e.*, Y_2 and Y_1). Plaintiff contends that the inference to be drawn is that they may be of any value. Thus, plaintiff contends, the two claimed computations are

$$b_1 = \int (b_2 Y_3 - b_3 Y_2)\, dt \text{ and } b_2 = \int (b_3 Y_1 - b_1 Y_3)\, dt$$

which are identical to two of the three computations claimed in claim 2. Defendant contends that the only proper interpretation of claim 3 is that the two unnamed projections (Y_2 and Y_3) must be consistently zero. Thus, defendant contends, the two claimed computations are

$$b_1 = \int (b_2 Y_3)\, dt \text{ and } b_2 = \int (-b_1 Y_3)\, dt$$

which are *not* identical to any of the three computations claimed in claim 2. However, the resolution of this dispute is irrelevant to the issue of claim validity under § 101 because, regardless of which interpretation is correct, the fact remains that a computation has been claimed.

[23] *See* n. 22, *supra*.

claimed, not the fact that a computation has been claimed. We conclude, therefore, that claim 3 is also invalid under the rationale of *Benson*.

4. *Claim 7*[24]

Claim 7 is identical to claim 6, except that it incorporates the language which distinguished claim 3 from claim 2. In other words, claim 7 is identical to claim 6, except that it calls for only *two* computations as opposed to the *three* computations called for by claim 6. Accordingly, for the same reasons given above for finding claim 3 nonstatutory, claim 7 is also directed to nonstatutory subject matter.

In summary, we have concluded that all of the claims in suit are invalid under the rationale of *Benson* and its progeny, because they preempt the mathematical formulae which they embody and, in practical effect, claim the mathematical formula itself. This conclusion, we think, is fortified by plaintiff's own admission that his invention is disclosed in a certain report, but that this report does not disclose *any* hardware or structure, *only mathematical equations*. *See* PRDRA at ¶ 17.

IV. *Summary and Conclusion*

While most courts are reluctant to grant summary judgment in patent cases involving technically sophisticated subject matter, *see e.g., Xerox Corp. v. Dennison Manufacturing Co.*, 322 F. Supp. 963, 966–67, 168 USPQ 700, 703 (S.D.N.Y. 1971), it is well established that summary judgment is permissible when the court can understand the relevant technology without the aid of expert opinion, *see e.g., Grayson v. McGowan*, 543 F.2d 79, 192 USPQ 571 (9th Cir. 1976). In the present case, the voluminous body of instructional materials offered in evidence by both parties and the helpful comments offered at the extensive and thorough oral hearing on the motions have enabled the court to sufficiently comprehend the

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[24] The full text of claim 7 is presented in Appendix A, *infra*.

subject technology to render a technically sound decision without hearing the testimony of technical expert witnesses.

Our analysis of the claims in suit and the accused structures has led us to conclude that all of the claims in suit fail to define an invention which is susceptible to patenting under 35 U.S.C. § 101 and are, therefore, invalid. In view of this finding, we have decided that it is unnecessary to rule on plaintiff's motion for summary judgment on the license and infringement issues, or other issues raised by either party.

For the reasons set forth herein, defendant's motion for summary judgment on the dispositive issue of invalidity is allowed, and plaintiff's motion for summary judgment on the issue of validity is denied. The petition is dismissed.

APPENDIX A

The asserted claims of the '052 patent read as follows:

> 2. A directional computer comprising a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, and means to receive the said input signals and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of the cross product vector between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.
>
> 3. A directional computer comprising a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity, the axes of said reference frame being denoted by the numerals **1**, **2**, **3**, means of obtaining an input signal

in representation of any desired value, said input signal being referred to said axis **3** to express an input vector, and means to receive the said input signal and generate a pair of output signals expressing an output vector in reference to said axes **1** and **2** as the integral of the cross product vector between the said output vector and the said input vector, whereby the said output vector is driven by the said input signal to rotate around the said axis **3**.

6. A directional computer comprising a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity, a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said second reference frame to express an input vector, and means, including said coordinate transformation means, to receive the said input signals and generate a plurality of output signals expressing an output vector in relation to said stabilized reference frame as the integral of the cross product vector between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

7. A directional computer comprising a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity, a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween, means of obtaining an input signal in representation of any desired value, said input signal being referred to an axis of said second reference frame to express an input vector, and means, including said coordinate transformation means, to receive the said input signal and generate a

plurality of output signals expressing an output vector in relation to said stabilized reference frame as the integral of the cross product vector between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

APPENDIX B

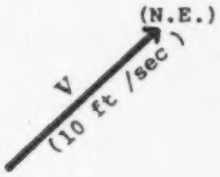
A. *Vectors*

Vectors are commonly used to describe certain physical quantities which require a statement of direction, as well as magnitude, to adequately specify the physical quantity. The velocity of a particle is one example of such a type of physical quantity. Although it would not be improper to specify the *magnitude* of the velocity alone (*e.g.*, 10 ft/sec), a full description of the vector quantity would require a statement of its *direction* as well (*e.g.*, N.E.). Physical quantities which require only a specification of magnitude to fully specify the physical quantity are known as scalars. Common examples of these are temperature, humidity, and time. When a vector is represented by a mathematical symbol, a horizontal line is drawn over that that symbol [or boldface is used] to indicate that it is representative of a vector quantity so that it may be distinguished from a scalar quantity. Thus the variable "V" is understood to be representative of a *scalar* quantity, while the variable "**V**" is understood to be representative of a *vector* quantity.

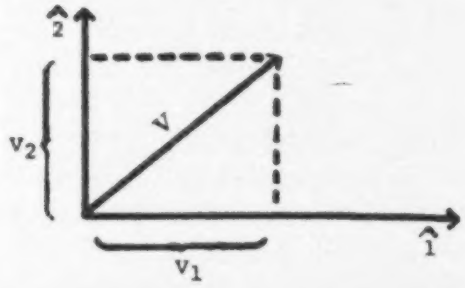
The specification of a vector quantity is always dependent on the frame of reference of its observer. For example, the velocity of a ball rolling on the floor of a moving train may appear to be relatively slow when viewed by a passenger seated on that train, but would appear to be relatively fast when viewed by an observer stationed on the ground near the train tracks. Thus, the specification of a vector quantity must always include a specification of the frame of reference with respect to

which the vector has been expressed. Otherwise, the expression would be meaningless.

A vector may be graphically illustrated by an arrow having a length proportional to the magnitude of the vector and pointing in the direction specified by the vector. Thus, for the velocity vector example given above, the vector (labeled for convenience as V) may be graphically illustrated as follows:



It is frequently useful to specify the vector, not in terms of its magnitude and direction, but in terms of its "projections" on the perpendicular axes of a special type of reference frame called a cartesian coordinate reference frame. Graphically, this may be represented as follows:



With the perpendicular axes of the cartesian coordinate reference frame defined as axes 1 and 2. the projection of the velocity vector, V, on the 1 axis would be the scalar quantity V_1, while the projection of the velocity vector , V, on the 2 axis would be the scalar quantity V_2.

The representation of a vector can be extended into three spatial dimensions. This would simply require the addition of a third axis, 3, which would be normal

(perpendicular) to the plane defined by axes **1** and **2**, and a projection of the vector, **V**, on that third axis to define the scalar quantity V_3. Therefore, when using a cartesian coordinate reference frame, a vector can be completely specified by reference to its three projections on the axes of that reference frame, *i.e.*, the scalar quantities V_1, V_2, and V_3. These quantities are also known as the "cartesian coordinates" of the vector.

B. *Vector Algebra*

Vectors are subject to many types of mathematical operations. One such operation which is important to an understanding of this case is the "cross product." The cross product between two given vectors, *e.g.*, **A** and **B**, always results in a third vector, *e.g.*, **C**, and is mathematically written as: $\mathbf{C} = \mathbf{A} \times \mathbf{B}$. The symbol "×" denotes "cross product" and is not to be confused with the use of that symbol to indicate mere multiplication of A and B. When the vectors are expressed by their cartesian coordinates (*i.e.*, $\mathbf{A} = A_1, A_2, A_3$; $\mathbf{B} = B_1, B_2, B_3$; $\mathbf{C} = C_1, C_2, C_3$), the result of the cross product between vectors A and B, *i.e.*, C_1, C_2, C_3, is defined by the following equations:

$$C_1 = A_2B_3 - A_3B_2;$$
$$C_2 = A_3B_1 - A_1B_3; \text{ and}$$
$$C_3 = A_1B_2 - A_2B_1.$$

Often a vector is expressed with respect to one frame of reference, but it is desirable to know its expression with respect to still another frame of reference. There is another mathematical operation called "coordinate transformation," which can be used to calculate this needed information. However, unlike the cross product, it is unnecessary to describe the mechanics of this computation.

For the purposes of this opinion, it is most important to understand that when the value of a vector expressed by three cartesian coordinates is calculated, the actual calculation requires three separate computations; *viz.*, one calculation for determining the value of each of the three

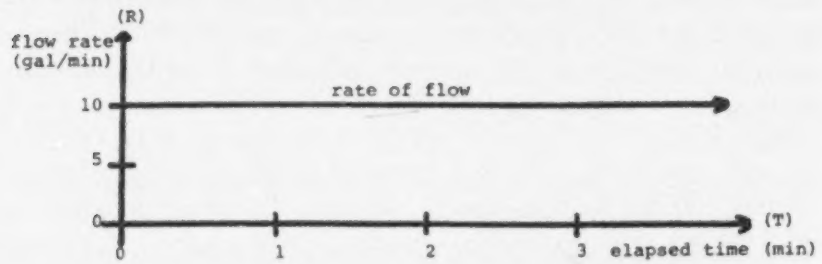
cartesian coordinates. Thus, although a vector equation may appear to require only a single calculation for its solution, the calculation in fact requires three separate computations when the result is expressed in cartesian coordinates.

C. *Vector Calculus*

Another type of mathematical operation to which a vector may be subjected is integration. Integration is a mathematical operation unique to calculus and is denoted by the mathematical symbol "$\int$". Although the integration operation is very difficult to appreciate conceptually, it may nevertheless be intuitively understood by considering one of the types of problems which it was designed to solve.

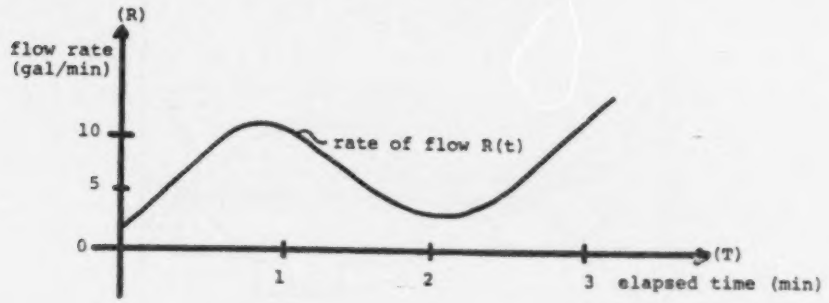
Suppose one knew the rate of flow of water (R) coming out of a hose and wanted to know the volume of water (V) expelled after the passage of a certain period of time (T). The answer would be easily calculated by using the well-known equation: volume (V) = rate of flow (R) multiplied by the elapsed time (T) or $V = RT$. For example, if the rate of flow, R, is 10 gallons per minute (*i.e.*, R = 10 gal/min), after the passage of 2 minutes (*i.e.*, T = 2 min), 20 gallons of water would have been expelled (*i.e.*, RT = V).

Graphically, the rate of flow, R, may be illustrated as follows:



Suppose, instead, that the water pressure was erratic and thus caused the *rate* of flow, R, to vary from time to

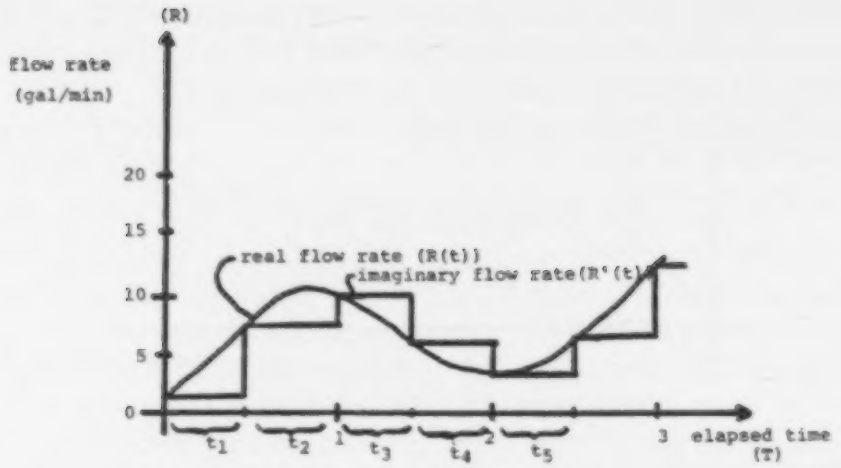
time. For example, suppose the rate of flow, R, followed the "profile" shown in the following graph:



On the graph, the rate of flow, R, has been indicated as "R(t)", rather than merely "R", to indicate that the rate is no longer constant, but varies as a function of time (the addition of "(t)" to a variable name to indicate that it varies as a function of time (t) is standard mathematical nomenclature). Now, the computation of the volume of water expelled, V(t), after the passage of a known period of time is not so easily calculated for the equation V = RT is not applicable when the rate of flow does not remain *constant* during the given time interval.

Nevertheless, the volume of water expelled, V(t), after the passage of 2 minutes, can be *approximated* by calculating the volume of water expelled by an imaginary water hose whose rate of flow profile, R'(t) (the apostrophe is used after the symbol "R" to distinguish the imaginary variables from the actual ones), is chosen to closely approximate the actual rate of flow profile, R(t), but has a shape susceptible to the application of the equation, V = RT.

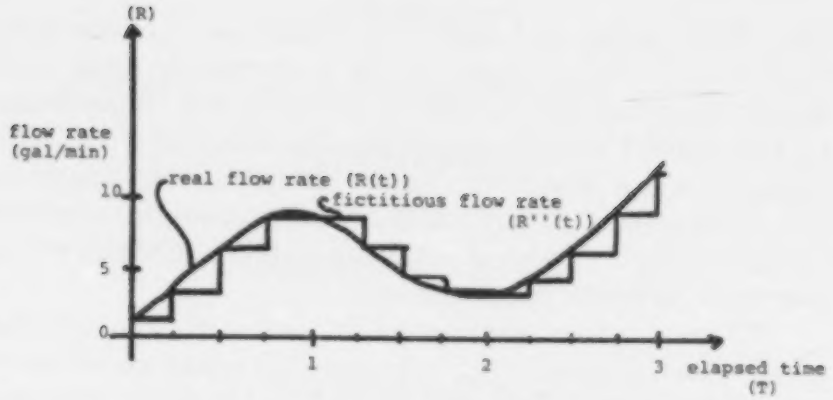
One such imaginary rate of flow profile, R'(t), may be created by sampling the real rate of flow profile, R(t), every half-minute and by maintaining the value of the imaginary rate of flow profile between samples equal to the value of the last rate of flow. Graphically this would appear:



Although the imaginary rate of flow, R'(t), does not remain constant during the entire 2 minute time interval, it does remain constant during each half-minute time interval (designated as t_1, t_2, t_3, and t_4). Thus, the volume of water expended by the imaginary water hose, V'(t), during *each* half-minute segment would simply be the imaginary rate of flow during that time segment, $R'(t_1)$, $R'(t_2)$, $R'(t_3)$, and $R'(t_4)$, times its respective flow time, t_1, t_2, t_3, and t_4, which in each case is one-half minute. Mathematically, therefore, the total imaginary volume of water expended after two minutes, V'(2 min), would be:

$$\begin{aligned} V'(2\text{ min}) &= V'(t_1) + V'(t_2) + V'(t_3) + V'(t_4) \\ &= R'(t_1)\,\tfrac{1}{2} + R'(t_2)\,\tfrac{1}{2} + R'(t_3)\,\tfrac{1}{2} + R'(t_4)\,\tfrac{1}{2} \\ &\approx V(2\text{ min}) \quad (\text{“}\approx\text{” means approximately equals.}) \end{aligned}$$

The error in the approximation of V(t) by equating it to V'(t) is directly related to the amount of difference between the two profiles. This difference can be minimized by increasing the frequency of samples in the imaginary rate of flow profile, R'(t). Thus, the following imaginary rate of flow profile, R"(t), which has twice as many samples per period of time as does R'(t), will yield an even more accurate approximation of V(t) than will V'(t):



As the density of the samples increases to infinity, R"(t) will become identical to R(t) and the accuracy of the approximation for V(t) based on a calculation of V"(t) will approach theoretical perfection. At the limit when the density of samples does reach infinity, the calculation process is defined as *integration* and is denoted by the following equation (for this particular problem):

$$V(t) = \int R(t)\,dt$$

where "dt" signifies an infinitesimal length of time.

Essentially, therefore, integration is a method to calculate *and* sum an infinite series of mathematical computations. However, because of the infinitesimal (microfinite) nature of the time which passes between calculations, integration is known as a "continuous" method of computation, while the sample method described above, because it involves the calculation of a series of time-separated computations, is known as an individual or "discrete" method of calculation.

Devices called "analog integrators" can actually perform an integration operation on electronic signals. There are also mechanical devices which can integrate. An example of a mechanical device which can actually perform the integration operation required to precisely calculate V(t) in the given example is, quite simply, a large bucket! If the water expelled from the hose is channeled into the large bucket, no matter how the rate of

flow, R(t), varies with time, the integrator, *i.e.*, the large bucket, will "keep track" of V(t) precisely. One need merely measure the volume of water in the large bucket at the desired time to ascertain the value of V(t). This example of an integrator serves to intuitively illustrate the fundamental difference between an integrator which "continuously calculates" and the sample method which performs "discrete computations."

When a vector, expressed in terms of its cartesian coordinates, is integrated, its three cartesian coordinates are separately integrated (which, therefore, requires three integrations). Mathematically stated, to perform $\mathbf{b} = \int \mathbf{Z}\,dt$, what really must be performed is:

$$b_1 = \int Z_1\,dt;$$
$$b_2 = \int Z_2\,dt; \text{ and}$$
$$b_3 = \int Z_3\,dt.$$

If we let $\mathbf{Z} = \mathbf{b} \times \mathbf{Y}$ in the above example, we know from the definition of cross products that:

$$Z_1 = b_2Y_3 - b_3Y_2;$$
$$Z_2 = b_3Y_1 - b_1Y_3; \text{ and}$$
$$Z_3 = b_1Y_2 - b_2Y_1.$$

and, therefore, the vector calculus equation $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y}\,dt$ is solved by solving the following three scalar calculus equations:

$$b_1 = \int (b_2Y_3 - b_3Y_2)\,dt;$$
$$b_2 = \int (b_3Y_1 - b_1Y_3)\,dt; \text{ and}$$
$$b_3 = \int (b_1Y_2 - b_2Y_1)\,dt.$$

We have examined the particular equation $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y}\,dt$ because an understanding of this particular equation is essential to an understanding of the claims in suit. With this knowledge in hand, the analysis of the legal issues in this case may be more easily perceived.

APPENDIX 4

In the United States Court of Claims

TRIAL DIVISION

No. 431–75

(Filed: May 11, 1979)

GEORGE ARSHAL

v.

THE UNITED STATES

ON DEFENDANT'S MOTION AND PLAINTIFF'S CROSS MOTION FOR SUMMARY JUDGMENT

OPINION*

BROWNE, *Trial Judge*: This action is brought by George Arshal (plaintiff) against the United States (defendant) under the provision of 28 U.S.C. § 1498(a) for recovery of reasonable and entire compensation for the alleged use or manufacture by or for defendant of the invention covered by claims 2, 3, 6, and 7[1] of his United States Patent No. 3,319,052 (the '052 patent), issued May 9, 1967, for a "Directional Computer." The application on which the patent is based was filed January 20, 1966 (Serial No. 533,106) as a continuation of a subsequently abandoned application (Serial No. 206,801) filed July 2, 1962.

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* The opinion and conclusion of law are submitted in accordance with Rule 54(b).

[1] The text of the asserted claims is set forth in Appendix A, *infra*.

Defendant moved for summary judgment on March 30, 1978, on the issue of validity, and plaintiff moved for summary judgment on April 7, 1978, on the issues of validity, infringement, and license. The court referred the motions to the trial judge on July 25, 1978, pursuant to Rule 54 for his opinion and recommendation for the conclusion of law.

Upon review of the motions, supporting briefs, and extensive oral arguments of both parties heard on February 7 and 8, 1979, we have concluded that the '052 patent is invalid but, if valid, is infringed; wherefore, plaintiff is not entitled to recover on his claim for reasonable and entire compensation. Accordingly, defendant's motion for summary judgment is granted, plaintiff's motion for summary judgment is denied and, since the holding of invalidity is dispositive of the case, the petition is dismissed.

I. *The Pleadings and Pretrial Proceedings*

A. *The Pleadings*

Plaintiff filed his petition, *pro se*, on December 12, 1975, after having failed to negotiate an administrative settlement of his claim with the Department of the Navy. In his petition, plaintiff alleges that claims 2, 3, 6, and 7 of his patent are infringed by the guidance system manufactured for and used by defendant in its Poseidon missile, and also by the guidance system intended for use in the Trident C4 (Trident) missile. Lockheed Missiles and Space Company, Inc., of Sunnyvale, California (Lockheed) is alleged to be the sole manufacturer of the missiles for defendant.

Defendant filed its answer to the petition on April 9, 1976. In its answer defendant admitted that the Poseidon missiles were supplied by Lockheed and used by defendant, and that certain plans exist with respect to manufacture and use of the Trident C4 missile by defendant. Defendant denied, however, that the patent

has been infringed or that it was duly and legally issued, or otherwise enforceable. Defendant contends that, in any event, it is licensed under the patent in suit.

B. *Pretrial Proceedings*

On April 20, 1976, the trial judge filed an "Inquiry re Further Proceedings" in which the parties were requested to inform the trial judge as to their intentions with respect to the conduct of further proceedings. It appeared from their responses that the case would not be settled by negotiation and that discovery would be necessary. Consequently, an order was issued on May 11, 1976, calling for completion of discovery by August 31, 1976, with the parties being required to file and serve their respective pretrial submissions in accordance with Rule 111(g), with a view to commencing trial prior to December 31, 1976 (a little more than 1 year after the date of filing the petition).

Voluntary discovery was hampered to some extent by virtue of security classification of certain of defendant's documents pertaining to missile guidance systems. Through mutual cooperation, however, these obstacles were overcome and plaintiff ultimately obtained access to all of the documents which he required. As a consequence of this delay, however, it was not possible to commence trial by December 31, 1976. A final pretrial conference was held on January 19, 1977, at which time it was concluded that the parties might work out a joint stipulation of facts whereby the matter might be submitted for determination under Rule 134(b), or at least to narrow the issues of fact to be tried. When it first appeared that progress was not being made because the parties were having difficulty in reaching an agreement as to the uncontested issues of fact, a further pretrial order on liability was issued on May 27, 1977. The purpose of this order was to enable the parties to better organize the material submitted in response to the order of May 11,

1976, either for trial or for submission of the case on stipulated facts under Rule 134(b).

As a consequence of the efforts of the trial judge and of the parties, much documentation has already been received in evidence and filed with the clerk. To the extent that the pending motions for summary judgment make reference to such evidence, it has been taken into consideration in rendering the present opinion and making the present recommendation for the conclusion of law.

II. *The Patent in Suit*

In order to comprehend the legal issues of this case, it is necessary first to have a basic understanding of the underlying mathematics of the invention, since it involves vectors, vector algebra, and vector calculus. A very brief discussion of these concepts is presented in Appendix B of this opinion. The discussion which follows presumes both a basic knowledge of elementary algebra and an understanding of the appended discussion of vector mathematics.

The '052 patent is entitled, "Directional Computer." It defines the invention as "a vectorial data processing system for extracting or prescribing directions and their rates of change from given input vectors." *See*, column 1, lines 13–15 of the patent. The specification specifically states that the output direction is affected by the input vector in one or both of the following two ways:

(1) So that the output direction rotates around the input vector to describe a conical surface.

(2) So that the output direction rotates directly towards the input vector and seeks coalignment. [*Id.* at col. 1, lines 27–31.]

The system is described as useful in aircraft flight control, as one example. It is also intended for use to "service demanding applications requiring wide ranging directional controls under a variety of options." [*Id.* at col.

1, lines 52–57.] The remaining portion of the specification describes the invention primarily in terms of vector algebra. The drawings illustrate examples of the relationship of the algebraic expressions disclosed in the specification in terms of circuit diagrams and other graphic symbols.

III. *Validity of the Claims Under 35 U.S.C. § 101*

A. *The Positions of the Parties*

Defendant has alleged in its motion for summary judgment that claims 2, 3, 6, and 7 of the patent are invalid because they are drawn to subject matter which is not patentable under the Patent Act of 1952 (Title 35, United States Code). Specifically, defendant contends that the claims, essentially, are drawn to a mathematical equation, and that a mathematical equation is not patentable subject matter under 35 U.S.C. § 101 (1976).[2]

Claim 2 of the patent is illustrative of all of the claims in suit and states:[3]

2. A directional computer comprising

   (a) a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity,

   (b) means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, and

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[2] 35 U.S.C. § 101 states: "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title."

[3] The claim has been broken down into three parts for analytical purposes. It does not appear in this format in the patent.

(c) means to receive the said input signals and generate a plurality of output signals *expressing an output vector in relation to said reference frame as the integral of the cross product vector between the said output vector and the said input vector*, whereby the said output vector rotates around said input vector. [Emphasis added.]

To support its position that claim 2 is essentially directed to a mathematical equation, defendant points to the italicized phrase in part (c) of claim 2. (This language also appears in the remaining claims in suit, namely, claims 3, 6, and 7). Although plaintiff does not dispute that this language is the verbal equivalent of a mathematical expression,[4] plaintiff points out that this language forms only a portion of the claim and that, when considered in its entirety, the claim is not directed to an equation, but to a *machine*.

B. *The Applicable Law*

Since mathematical expressions or equations, *per se*, are not susceptible to patent protection under section 101 of the Patent Act,[5] we must determine whether or not the asserted claims define an invention which is merely a mathematical expression or equation. If the mathematical expression or equation is simply an adjunct to the invention sought to be covered, the inclusion thereof in the claims is not fatal to their validity. If, however, the

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[4] Specifically, the language recites the mathematical expression $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} \, dt$, where **Y** represents a desired input vector and **b** represents a directional output vector.

[5] Section 101 of the Patent Act, *see* fn. 2, *supra*, does not expressly *exclude* a mathematical expression or equation as patentable subject matter. Case law, however, has established that they are not included. *See e.g., Gottschalk v. Benson*, 409 U.S. 63, 175 USPQ 673 (1972); *Mackay Co. v. Radio Corp.*, 306 U.S. 86, 40 USPQ 199 (1938).

invention itself can be expressed only in terms of the mathematical expression or equation, it is outside the scope of 35 U.S.C. § 101 and, therefore, is invalid under the applicable case law.

Tests for determining whether a claim is directed to subject matter which is not patentable have been applied in some cases which predated the 1952 Patent Act, and many others subsequent to that Act. In some early cases, because the "point of novelty" or truly novel element in the claims was determined to be a mathematical expression or equation, the claims were held to be nonstatutory.[6] *See e.g., In re Abrams*, 188 F.2d 165, 89 USPQ 266 (CCPA 1951).

The "point of novelty" test was, at first, followed after the effective date of the 1952 Act, but was formally rejected by the Court of Customs and Patent Appeals (CCPA) in *In re Bernhart*,[7] 417 F.2d 1395, 163 USPQ 611 (CCPA 1969).[8] In *Bernhart*, among the claims before the court was an apparatus claim directed to a general purpose computer programmed to calculate the results of a complex mathematical equation. In reversing the Examiner's rejection of this claim (which was based upon

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[6] The word "nonstatutory" is sometimes used to apply to a claim directed to subject matter which is not expressly entitled to patent protection.

[7] As a point of fact, the CCPA first rejected this approach in *In re Prater*, 415 F.2d 1378, 159 USPQ 583 (CCPA 1968). However, the opinion in *Prater* was subsequently vacated, 415 F.2d 1378, 160 USPQ 230, and replaced by an opinion which did not discuss the propriety of the "point of novelty" test, *see* 415 F.2d 1393, 162 USPQ 541 (CCPA 1969).

[8] The decisions of the Court of Customs and Patent Appeals, while being neither controlling nor binding on this court, are nevertheless accorded great weight and respect in view of the manifest expertise of that court in determining whether or not claims presented in pending applications for patents satisfy the requirements of the patent statutes.

the Examiner's belief that the novelty of the claim lay in the equations with which the computer was programmed), the court stated:

> The principle [behind the Examiner's rejection] may, we think be fairly stated as follows: If, in an invention defined by a claim, the novelty is indicated by an expression which does not itself fit in a statutory class (in this case not a machine part thereof), then the whole invention is non-statutory since all else in the claim is old. We do not believe this view is correct under the Patent Act and the case law thus far developed. [*Id.* at 1399, 163 USPQ at 615–16.]

Instead, the court concluded that:

> [I]f a machine is programmed in a certain new and unobvious way, it is physically different from the machine without that program; its memory elements are differently arranged. The fact that these physical changes are invisible to the eye should not tempt us to conclude that the machine has not been changed. If a new machine has not been invented, certainly a "new and useful improvement" of the unprogrammed machine has been, and Congress has said in 35 U.S.C. 101 that such improvements are statutory subject matter for a patent. [*Id.* at 1400, 163 USPQ at 616.]

The CCPA reaffirmed its rejection of the "point of novelty" test in *In re Musgrave*, 431 F.2d 882, 167 USPQ 280 (CCPA 1970), and pointed out the fallacy in that test:

> [I]t is our view that [the point of novelty test is] logically unsound. According to [this test], a process containing both "physical steps" [the statutory portion] and so-called "mental steps" [the nonstatutory portion] constitutes statutory subject matter if the "alleged novelty or advancement in the art resides in" steps deemed to be "physical" and nonstatutory if it resides in steps deemed to be "mental". It should be apparent, however, that novelty and advancement of

> an art are irrelevant to a determination of whether the nature of a process is such that it is encompassed by the meaning of "process" in 35 U.S.C. 101. Were that not so, as it would not be if [the point of novelty test] were the law, a given process including both "physical" and "mental" steps could be statutory during the infancy of the field of technology to which it pertained, when the physical steps were new, and nonstatutory at some later time after the physical steps became old, acquiring prior art status, which would be an absurd result. Logically, the identical process cannot be first within and later without the categories of statutory subject matter, depending on such extraneous factors. [*Id.* at 889, 167 USPQ at 286–87.]

Instead, the court stated that all that was needed to make the claimed process statutory under 35 U.S.C. § 101 was "that it be in the technological arts so as to be in consonance with the constitutional purpose to promote the progress of 'useful arts'." 431 F.2d at 893, 167 USPQ at 289–90. Finding the claims at issue to be within the technological arts, the court reversed the examiner's rejection.

The new "technological arts" test was reaffirmed by the CCPA in *In re Foster*, 438 F.2d 1011, 169 USPQ 99 (CCPA 1971), as it stated that "it is not important whether the claims contain mental steps [the nonstatutory portion] or not if the process is within the technological arts." *Id.* at 1015, 169 USPQ at 101. And in *In re Waldman*, 457 F.2d 997, 173 USPQ 430 (CCPA 1972), the CCPA explained that "[t]he phrase 'technological arts', as we have used it, is synonymous with the phrase 'useful arts' as it appears in Article I, Section 8 of the Constitution." *Id.* at 1003, 173 USPQ at 434.

In *In re Benson*, 441 F.2d 682, 169 USPQ 548 (CCPA 1971), the CCPA again applied their "technological arts" test to reverse a section 101 rejection of a claim drawn to a method of converting one form of numerical representation into another, utilizing a novel algorithm. After

concluding that the process had no practical use except in connection with a digital computer, the court stated:

> It seems beyond question that the machines—the computers—are in the technological field, are a part of our best-known technologies, and are in the "useful arts" rather than the "liberal arts" as are all other types of "business machines," regardless of the uses to which their users may put them. How can it be said that a process having no practical value other than in enhancing the internal operation of these machines is not likewise in the technological or useful arts? We conclude that the Patent Office has put forth no sound reason why the claims in this case should be held to be nonstatutory. [*Id.* at 688, 169 USPQ at 533.]

Certiorari was granted in *Benson*, and the Supreme Court, however, *reversed*. *Gottschalk v. Benson*, 409 U.S. 63, 175 USPQ 673 (1972). The Supreme Court began by pointing out that the case law has well established the principle that one may not patent an *idea*. Directing its attention to the *claims* at issue, the Court found two fatal objections to their validity: first, that "the claims were not limited to any particular art or technology, to any particular apparatus or machinery, or to any particular end use," *id.* at 64, 175 USPQ at 674, but were "so abstract and sweeping as to cover both known and unknown uses" of the *claimed* invention, *id.* at 68, 175 USPQ 675; and second, that because the mathematical formula embodied in the *claims* had "no substantial practical application except in connection with a digital computer", "the patent [claims] would wholly preempt the mathematical formula and in practical effect would be a patent on the algorithm itself." *Id.* at 71–72, 175 USPQ at 676.

The determination of whether a *claim* preempts nonstatutory subject matter under the rationale of *Benson* has been determined to require a two-step analysis:

> First, it must be determined whether the claim recites an "algorithm" in the *Benson* sense of that term, for a claim which fails to even recite an algorithm clearly cannot wholly preempt an algorithm. Second, the claim must be further analyzed to ascertain whether in its entirety it wholly preempts that algorithm. [*In re Freeman*, 573 F.2d 1237, 1245, 197 USPQ 464, 471 (CCPA 1978)].

We now direct our attention to that analysis.

Plaintiff contends that his claims do not recite an "algorithm" in the *Benson* sense, but are directed to "physical geometry." (*See* plaintiff's response to defendant's motion for summary judgment under Rule 101 (filed May 3, 1978) at p. 43.) Specifically, plaintiff states that his claims are distinguishable from those in *Benson* because his are "concerned with creating a circumstance," while those in *Benson* are concerned with "determining the value of a variable that already exists in the context of a specific set of circumstances." *Id.* We find, however, this distinction, if it is one at all, to be of no consequence. The important point is that the claims both in *Benson* and in this suit are directed to a particular means for transforming defined input signals into useful output signals. Although *Benson* did not render all algorithms (as defined by the dictionary) to be nonstatutory, subsequent case law has clearly established that a formula or equation, even if expressed in its prose equivalent, is the type of subject matter to which the *Benson* rationale must be applied. *See In re Freeman*, 573 F.2d at 1246, 197 USPQ at 471 (and cases cited therein).

Plaintiff further argues that *Benson* is inapplicable because the claims in *Benson* are drafted in the form of a "method," whereas the claims in this suit are drafted in the form of an "apparatus" (using "means plus function" language).[9] However, even the language used in *Benson*

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[9] It should be noted that plaintiff, who prosecuted his patent application *pro se*, did not have the benefit of the courts'

itself indicates that the fundamental principles governing the statutory determination of "method" claims is equally applicable to "apparatus" claims:

> As we stated in *Funk Bros. Seed Co. v. Kalo Co.*, "He who discovers a hitherto unknown phenomenon of nature has no claim to a monopoly of it which the law recognizes. If there is to be invention from such a discovery, it must come from the application of the law of nature to a new and useful end." *We dealt there with a "product" claim while the present case deals only with a "process" claim. But we think the same principle applies.* [409 U.S. at 67–68, 175 USPQ at 675 (citations omitted and emphasis added)].

As the CCPA stated in *In re Freeman*, it is not the form of the claim which is controlling but its substance:

> Though a claim expressed in "means for" (functional) terms is said to be an apparatus claim, the subject matter as a whole of that claim may be indistinguishable from that of a method claim drawn to the steps performed by the "means" . . . . [I]f allowance of a method claim is proscribed by *Benson*, it would be anomalous to grant a claim to apparatus encompassing any and every "means for" practicing that very method. [573 F.2d at 1247, 197 USPQ at 472 (footnote omitted)].

To do otherwise would make the determination of patentable subject matter depend simply on the draftsman's skill which would ill serve the principles underlying the prohibition against patents for ideas. *See Parker v. Flook*, 437 U.S. 584, 593, 198 USPQ 193, 198 (1978).

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decisions rendered after May 9, 1967, since the patent issued on that date was based on his application which was first filed in 1962 and refiled in 1966. *In re Abrams*, *supra*, was the only significant precedent available during the pendency of plaintiff's applications.

Plaintiff finally urges that *Benson* is inapplicable because *Benson* dealt with an algorithm used only in digital computers, whereas plaintiff's patent discloses his equation for use in analog computers. While it is true that the Supreme Court in *Benson* expressly declined to extend its holding to algorithms used in analog computers,[10] it is also true that they did not in any way disapprove of such an extension. As we can see no factual reason for making such a legal distinction, we believe that the rationale of *Benson* is equally applicable to algorithms used in analog computers. This conclusion, however, is unnecessary to our decision as the claims in suit are in no way limited to analog computers. That the specification may disclose analog computers in one embodiment of the claimed invention is irrelevant. Although the specification may be properly used to *interpret* limitations already present in the claims, *Westwood Chemicals, Inc. v. United States*, 207 Ct. Cl. 791, 525 F.2d 1367, 187 USPQ 656 (1975), the specification may never be used to *add* additional and otherwise nonexistent limitations to those claims, *Siegler v. Watson*, 267 F.2d 621, 121 USPQ 119 (D.C. Cir. 1959). To be sure, not even plaintiff seriously contends that his claims do not encompass digital computers for plaintiff, himself, contends that defendant's alleged infringing computer, which is a digital computer, is fully encompassed by his patent claims. It is a fundamental principle of patent law that a claim may not be narrowly construed to avoid invalidity and then broadly construed to encompass the accused device. *See e.g., Dominion Magnesium Ltd. v. United States*, 162 Ct. Cl. 240, 319 F.2d 1872, 138 USPQ 306 (1963).

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[10] Specifically, the Court stated: "It is said that we have before us a program for a digital computer but extend our holding to programs for analog computers. We have, however, made clear from the start that we deal with a program only for digital computers." 409 U.S. at 71, 175 USPQ at 676.

Accordingly, the rationale of *Benson* is applicable to a determination of validity of the claims in this case. The issue to which we now direct our attention is whether, under the rationale of *Benson*, these claims "wholly preempt the mathematical formula" which they incorporate.

C. *Application of the Law to the Claims*

1. Claim 2[11]

Claim 2 recites three elements which can, functionally, be summarized as follows:

(a) a physically defined, stabilized reference frame[12]

(b) means of obtaining input signals defining an input vector in relation to the stabilized reference frame; and

(c) means to calculate $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt$, where $\mathbf{Y}$ is the input vector, $\mathbf{b}$ is the output vector, and the integration is relative to the stabilized reference frame.[13]

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[11] For the full text of claim 2, see Appendix A, *infra*.

[12] This element is further described in the claim as "having means of sensing and suppressing its angular velocity." However, it is clear from the specification that this language merely clarifies the essential nature of a "stabilized reference frame" and thus is without limiting effect. *See* col. 5, lines 4–9. To be sure, plaintiff wholly agrees with this conclusion. *See* PRDMSJ at ¶ 49.

[13] This element is further described in the claim by the language "whereby the said output vector rotates around the said input vector." However, this language has no limiting effect for it is clear that in every implementation of the claimed equation the "output vector rotates around the said input vector" whether it rotates to trace a conical surface around the input vector or seeks coalignment with it. *See also* n. 43, *infra*.

The statement that "the integration is relative to the stabilized reference frame" is used to mean what the inventor in his specifications has defined it to mean, namely that the vector

The Supreme Court has indicated in *Benson* that a claim should be "limited to [a] particular art or technology, to [a] particular apparatus or machinery, [and] to [a] particular end use." 409 U.S. at 64, 175 USPQ at 674. If we consider only element (c) of claim 2 for the moment, it is clear that it violates each and every requirement of this rule. First, it in no way specifies any use for the calculated output vector and, therefore, is not "limited to any particular end use." Second, the "means plus function" language encompasses any and every type of apparatus or machine which could be used to implement the claimed equation and, therefore, the element is not "limited to any particular apparatus or machinery." Finally, the element has application in arts or technologies as diverse as the equation itself and, therefore, is not "limited to any particular art or technology." The element truly does, in the *Benson* sense, wholly preempt the mathematical formula which it embodies.

Of course, claim 2 recites more than merely element (c). However, the effect of additional elements (a) and (b) in claim 2 is insufficient to factually or legally distinguish the claim from the type held to be unpatentable in *Benson*. The reason for this conclusion becomes clear upon an understanding of the purpose of these elements.

As we have stated above, element (c) merely calls for means to perform a mathematical computation which, by itself, is unpatentable subject matter. Because the equation recited in element (c) is a calculation using an input vector, *i.e.*, **Y**, apparatus performing that calculation necessarily requires means to generate the value of the input vector, **Y**. Element (b) is for just that purpose and, therefore, is essential to the performance of the computation. Thus, the "limitation" in the claim effectuated by the addition of element (b) is, for all practical

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quantities of the integrand, *i.e.*, **b** and **Y** are expressed in reference to the stabilized reference frame. *See* cols. 4 and 5, lines 64–75 and 1–4, respectively.

purposes, not a limitation at all because element (c) cannot function in the absence of element (b). Of course, if element (b) recited apparatus which generated a *particular* type of input signal, such as a specified physical quantity, our conclusion might be different. But it does not, and, in fact, it states that the input signals defining the input vector may be representative of "any desired value."

The same is true of element (a). Because the equation claimed in element (c) operates exclusively on vectors, as we have pointed out in our background mathematics discussion, Appendix B, *infra*, all vectors *must* be expressed in terms of a frame of reference and, therefore, a reference frame is also essential to the implementation of the claimed equation.[14] This is the purpose of element (a) and it too, therefore, is essential to the performance of the computation claimed in element (c). While it is true that element (a) is limited to a particular type of reference frame, *i.e.*, a "physically defined, stabilized reference frame," the very nature of the claimed equation requires this specific type of reference frame to produce a meaningful result.[15]

In *In re Christenson*, 478 F.2d 1392, 178 USPQ 35 (CCPA 1973), the CCPA was presented with a similar case. The claim at issue contained a mathematical equation and several "data gathering" steps. In rejecting the

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[14] Plaintiff wholly agrees with this statement. *See* n. 25, *infra*.

[15] The claimed equation, $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt$, is but one embodiment of the more general equation $\mathbf{b} = \int ((A/b^2 - B)\mathbf{b} + \mathbf{b} \times \mathbf{Y} + \mathbf{b} \times \omega) dt$, (*see* col. 4, equation (17)) with $A/b^2 - B = \omega = 0$ by definition. To make $\omega = 0$, however, *requires* a "physically defined, stabilized reference frame." *See* col. 5, lines 1–7. Thus, the claimed equation cannot be meaningfully implemented with any other type of reference frame. *Accord, see* plaintiff's submission to the standard pretrial order on liability (PSPOL), ¶¶ 23, 24 (filed February 27, 1978).

contention that the addition of "data gathering" steps could convert a nonstatutory claim into statutory subject matter, the court said:

> Given that the *method of solving* a mathematical equation may not be the subject of patent protection, it follows that the addition of old and necessary antecedent *steps of establishing values for the variables in the equation* cannot convert the unpatentable method to patentable subject matter. [*Id.*, at 1394, 178 USPQ at 37–38 (emphasis supplied)].

The rationale behind this pronouncement of law was later explained by Chief Judge Markey in *In re Sarkar*, 588 F.2d 1330, 200 USPQ 132 (CCPA 1978):

> No mathematical equation can be used, as a practical matter, without establishing and substituting values for the variables expressed therein. Substitution of values dictated by the formula has thus been viewed as a form of mathematical step. If the steps of gathering and substituting values were alone sufficient, every mathematical equation, formula, or algorithm having any practical use would be per se subject to patenting as a "process" under § 101. [*Id.*, at 1335, 200 USPQ at 139.]

Even where the antecedent "data gathering" steps are novel and unobvious, their recitation in combination with a mathematical computing step is legally insufficient to give rise to a patentable claim under § 101 of the Patent Act. *In re Richman*, 563 F.2d 1026, 195 USPQ 340 (CCPA 1977); *accord*, *In re Sarkar*, *supra*, at n. 18.

Of course, these CCPA precedents dealt with claimed *processes*, not *apparatus*. However, as we have already pointed out, the controlling principles are the same. Otherwise, the anomaly might result that a claim to apparatus encompassing any and every means for performing a method might be valid while, at the same time, a claim encompassing all methods of obtaining the

desired result might be proscribed by *Benson*. *In re Freeman*, 573 F.2d at 1247, 197 USPQ at 472.

Plaintiff maintains, however, that claim 2 does not preempt a mathematical equation because the preamble "[a] directional computer" adequately limits the scope of the claim to a particular technology, *i.e.*, the directional computer technology. We find as a matter of law, however, that those words do not effectively limit the claim to any *particular* technology.[16]

First of all, computers are applicable to all technologies, not to any *particular* technology. Although the type of computer is specified as a "directional" computer, in the present case, this is a limitation without substance because vector computations (the type of computation recited in the claim), by definition, include directional computations. Thus, the claimed mathematical formula already intrinsically calls for directional computations and, therefore, use of the word "directional" in the preamble creates no additional limitation.

Second, there is a substantial question whether words in a preamble which do not appear in the body of the claim may even properly be used to limit the scope of the claim. *See e.g.*, *Strador v. Watson*, 244 F.2d 737, 113 USPQ 365 (D.C. Cir. 1957). Where, as here, the effect of the words are at best ambiguous (*i.e.*, as pointed out above, there is uncertainty whether the words have any limiting effect on the scope of the claim), a compelling reason must exist before the language can be given weight. *Cf. In re de Castelet*, 562 F.2d 1236, 1244, n. 6, 195 USPQ 439, 447, n. 6 (CCPA 1977) ("Where there is a potential for misconstruction of preamble language, a compelling reason must exist before the language can be given weight.") We can see no such reason in this case,

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[16] While the specification describes the invention as being a "vectorial data processing system" which is useful in "aircraft flight control," all of the claims are directed to a "directional computer," without recitation or limitation as to *any* field of use.

for the language in the body of claim 2, standing alone, is clear and unambiguous.

Even assuming, *arguendo*, that the preamble language "[a] directional computer" does have the effect of limiting the scope of claim 2 to a particular technology, the fact remains that claim 2 still preempts a mathematical equation, albeit in a limited and specific application. As the CCPA established in *In re Waldbaum*, 559 F.2d 611, 196 USPQ 465 (CCPA 1977), preemption of a mathematical calculation is fatal to the validity of a claim regardless of the scope of that preemption:

> [C]laims 1, 2 and 19 do not represent "no less of a 'computer processing program' than did claim 8 in *Benson*," because they are limited to the specific application of calculating the number of busy and idle lines in a telephone system. They would not preempt all uses of the algorithm [citing uses of the algorithm outside of the claimed invention], but would preempt only the use of the algorithm in calculating the number of busy and idle lines in a telephone system. At the same time, it must be recognized that a patent on these claims would, in practical effect, be a patent on the algorithm itself—albeit in its limited, specific application to calculating the number of busy and idle lines in a telephone system. . . . .
>
> In view of the foregoing, we hold that claims 1, 2 and 19 do not define a statutory process within the meaning of 35 U.S.C. §§ 100 and 101. [*Id.* at 617, 194 USPQ at 469–70 (footnotes omitted)].

Similarly, the Supreme Court recently held in *Parker v. Flook*, 437 U.S. 584, 595, 198 USPQ 193, 199 (1978), that "a claim for an improved method of calculating, even when tied to a specific end use, is unpatentable subject matter under § 101."

It is important to point out that a claim is not invalid merely because it recites a mathematical equation or computation. *Parker v. Flook*, *supra*. Rather, a claim

reciting a mathematical equation or computation as one of its elements will be invalid only if, when considered in its entirety, the essence of the claim is nothing more than that element. Although the line of demarcation between a patentable and an unpatentable (or non-patentable) claim "does not always shimmer with clarity," *Id.*, a persuasive index of a valid mathematical-calculating type of claim is when the claimed computation or equation is used not merely to calculate a numerical value, but is used to effectuate a physical result. For example, the CCPA recently held a series of claims directed to methods for removing unwanted noise from seismic data not to be invalid under § 101 because the purpose of the claimed invention was to "filter out extraneous and erroneous components and to physically record a noiseless seismic trace on a record medium," rather than to merely "compute a new value." *In re Johnson*, 589 F.2d 1070, 200 USPQ 199 (CCPA 1978). As is apparent from a reading of claim 2 of the patent in suit, however, the sole purpose of the invention recited therein is merely to "compute a new value." Thus, for this reason and all of the reasons discussed above, we conclude that, under the rationale of *Benson* and its progeny, unlike the claims in *Johnson*, claim 2 is invalid.

2. *Claim 6*[17]

We find the additional language placed in the remaining claims in suit insufficient to distinguish them from nonstatutory claim 2, as a matter of law. With respect to claim 6, the parties agree that it differs from claim 2 in that it calls for the following additional elements:

(d) a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween,

(e) the input signals being referred to the second reference frame to express an input vector, and

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[17] The full text of claim 6 is recited in Appendix A, *infra*.

(f) the "means" receiving the input signals and generating the output signals to include the coordinate transformation means in (d) above.

See PRDRFA at ¶ 21. The essential difference between claim 6 and nonstatutory claim 2, therefore, is that claim 6 calls for an *additional* data gathering element, the "second reference frame," and for an additional mathematical calculating element, the "means to perform a coordinate transformation."[18] Certainly, the addition of a second mathematical calculating element (an element which is on its face nonstatutory), cannot change a nonstatutory claim into one which is statutory; and we think that, given the principle that the addition of a "data gathering" element cannot change an otherwise nonstatutory claim into a statutory claim, the inclusion of an *additional* "data gathering" element in the claim will also not have that effect. Accordingly, we conclude that claim 6 does not define an invention which is entitled to patent protection under 35 U.S.C. § 101. We now consider the effect of the differences between claim 3 and claim 2.

3. Claim 3[19]

When the value of the output vector, **b**, recited in claim 2 is computed, as we have explained in the mathematical background discussion, *infra* at Appendix B, what is actually computed is the scalar values of the output vector's three projections on the axes of a cartesian coordinate reference frame, *i.e.*, b_1, b_2, and b_3. Thus, while claim 2 recites only a single mathematical equation, *i.e.*, $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt$, the solution of that equation requires the

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[18] The specifications disclose that the "means to perform a coordinate transformation" is merely apparatus which performs a series of known mathematical computations. *See* cols. 6 and 7, lines 15–17 and 1–3, respectively.

[19] The full text of claim 3 is presented in Appendix A, *infra*.

following three separate computations (a fact not disputed by the parties):[20]

$$b_1 = \int (b_2Y_3 - b_3Y_2)\,dt;$$
$$b_2 = \int (b_3Y_1 - b_1Y_3)\,dt; \text{ and}$$
$$b_3 = \int (b_1Y_2 - b_2Y_1)\,dt.$$

Claim 3, on the other hand, expressly limits its scope by defining only the third axis projection (Y_3) with respect to the reference frame. Unlike claim 2, the remaining projections of the input vector (*i.e.*, Y_2 and Y_1) are not expressly defined. Also, unlike claim 2, only *two* of the projections of the output vector are calculated (b_1 and b_2),[21] rather than the full set (b_1, b_2, and b_3) calculated by the apparatus recited in claim 2. Based upon this analysis (the accuracy of which is not disputed), the only difference between claim 3 and claim 2 is that claim 3

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[20] The derivation of these equations is shown in the background mathematics discussion, *infra* at Appendix B.

[21] The parties dispute the implication to be drawn from the failure of the claim to expressly define the value of two of the three projections of the input vector (*i.e.*, Y_2 and Y_1). Plaintiff contends that the inference to be drawn is that they may be of any value. Thus, plaintiff contends, the two claimed computations are

$$b_1 = \int (b_2Y_3 - b_3Y_2)\,dt \text{ and } b_2 = \int (b_3Y_1 - b_1Y_3)\,dt$$

which are identical to two of the three computations claimed in claim 2. Defendant contends that the only proper interpretation of claim 3 is that the two unnamed projections (Y_2 and Y_3) must be consistently zero. Thus, defendant contends, the two claimed computations are

$$b_1 = \int (b_2Y_3)dt \text{ and } b_2 = \int (-b_1Y_3)dt$$

which are *not* identical to any of the three computations claimed in claim 2. However, although the resolution of this issue is of obvious importance to the question of infringement, it is irrelevant to the issue of claim validity under § 101 because, regardless of which interpretation is correct, the fact remains that a computation has been claimed.

calls for apparatus which performs only *two* computations, while claim 2 intrinsically calls for apparatus which performs *three* computations. This difference, however, does not make claim 3 any less "abstract" or "sweeping" in the *Benson* sense than claim 2. It merely alters the quantity and perhaps the substance[22] of the computations claimed, not the fact that a computation has been claimed. We conclude, therefore, that claim 3 is also invalid under the rationale of *Benson*.

4. *Claim 7*[23]

Claim 7 is identical to claim 6, except that it incorporates the language which distinguished claim 3 from claim 2. In other words, claim 7 is identical to claim 6, except that it calls for only *two* computations as opposed to the *three* computations called for by claim 6. Accordingly, for the same reasons given above for finding claim 3 nonstatutory, claim 7 is also directed to nonstatutory subject matter.

In summary, we have concluded that all of the claims in suit are invalid under the rationale of *Benson* and its progeny, because they preempt the mathematical formulae which they embody and, in practical effect, claim the mathematical formula itself. This conclusion, we think, is fortified by plaintiff's own admission that his invention is disclosed in a certain report, but that this report does not disclose *any* hardware or structure, *only mathematical equations*. *See* PRDRA at ¶ 17.

IV. *Validity of the Claims Under 35 U.S.C. § 103*

Defendant also contends that the subject claims are invalid because they fail to meet the requirements of section 103 of the Patent Act.[24] While defendant has

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[22] *See* n. 21, *supra*.

[23] The full text of claim 7 is presented in Appendix A, *infra*.

[24] Section 103 provides: "Conditions for patentability; non-obvious subject matter. A patent may not be obtained though

enumerated many grounds for this defense in its response to this court's standard pretrial order on liability (filed May 27, 1977), it has chosen to rely upon only two of these grounds in its motion for summary judgment.

Defendant's first ground is that "claims 2, 3, 6 and 7 are invalid for obviousness because the distinguishing features on which their allowance [by the Examiner] was based were old." In particular, defendant contends that the file wrapper of the subject patent establishes that claims 2, 3, 6, and 7 were allowed over the prior art *only* because they were finally amended to specifically include a reference frame "having means of sensing and suppressing its angular velocity," and that, because plaintiff has admitted that such an element is itself old,[25] under *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), the claims must be held to be invalid. Our analysis of the underlying legal and factual basis for this contention, however, leads us to the conclusion that it is wholly without merit.

It is true that in *Graham* the Court did state that because the "patentee obtained his patent only by accepting the limitations imposed by the examiner," "[t]he subject matter as a whole reduces, then to the[se] distinguishing features." *Id.* at 33–34, 148 USPQ at 473. However, it is equally true that the prior art which the

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the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made."

[25] Specifically, plaintiff has admitted that "a physically defined stabilized reference frame having means of sensing and suppressing its angular velocity" is disclosed in U.S. Patent No. 2,752,793 to Draper, *et al.* (filed in 1951). *See* PRDRA at ¶ 42.

Court relied upon to invalidate the patent claims under consideration disclosed many elements of the claim in addition to the "distinguishing features." Thus, this case does not really stand for the proposition that a claim is automatically invalidated by prior art merely because it discloses *in isolation* those elements of a claim upon which allowance of the claims was based. To the contrary, it is settled law that validity of a claim must be judged by the claimed subject matter *taken as a whole*. *E.g.*, 35 U.S.C. § 103; *Parker v. Flook*, 437 U.S. at 594, 198 USPQ at 199.

Defendant's contention is not only unsupported by the law, but its basic factual premise, *i.e.*, that the distinguishing feature of the claim is old, is erroneous. Although it is true that the claims were allowed over the prior art only after they were amended to recite a *reference frame* "having means of sensing and suppressing its angular velocity," contrary to defendant's assertion, this did not mean that the examiner viewed this special type of reference frame as the *sole* distinguishing feature of the claims. To the contrary, the prosecution history clearly demonstrates that the claimed *equation*, not the special type of reference frame, was the material "distinguishing feature" of the claims,[26] and defendant has not even

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[26] Prior to allowance, the claims were rejected on prior art which disclosed the equation $\mathbf{V} = \int_F \mathbf{A}\,dt + \int_F \omega \times \mathbf{V}\,dt$, where ω represented the angular velocity of a physically defined reference frame F, and **A** and **V** were other vectors referenced to F (note that the claimed equation is $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y}\,dt$). The examiner stated that the prior art teaches "the integral of the cross product of two vector quantities" and that it "is not of patentable significance what variable the applicant claims his vectors represent." In response, the applicant contended that it was not proper to equate the prior art angular velocity vector, ω, with the input vector, **Y**, because the angular velocity vector, ω, of his reference frame was always of zero value. Thus, the applicant contended, it was "impossible to derive from the 'teaching of [the prior art]'

alleged, much less demonstrated, that the claimed *equation* existed in the prior art.

Defendant's second ground is that the claims are invalid for obviousness because they call for hardware which would have been obvious from a knowledge of the claimed equation. While this may be true,[27] as we have pointed out heretofore, defendant has not even asserted, let alone established, that the claimed equation was known in the art. Accordingly, we fail to see how the invention as a whole, as defined by the claims, would have been obvious to those skilled in the art, since those skilled in the art could not have been aware of the equation on which the remaining claim elements depend. Defendant's answer to this dilemma is that the equation is a "principle or natural law" and, as such, must be presumed to have been known, whether or not it was, in fact, known. We disagree.

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a device that is equivalent to mine." Although the examiner apparently was persuaded by this argument, he did not see how the claims limited the rotational velocity vector, ω, to a zero value and, accordingly, saw no difference between the equation *claimed* and the equation in the *prior art*. Although the applicant felt the limitation on ω was already implicit in his claims, he added the language "having means of sensing and suppressing its angular velocity" *to the reference frame* so as to explicitly force ω to a zero value. Thus, the addition of this crucial language was not to distinguish the claimed reference frame from the prior art, but to distinguish the claimed *equation* from the prior art.

[27] Plaintiff has already admitted that all of the claimed elements, except the equation, were old. *See* PRDRA at ¶¶ 16(b), 22, 28, and 42. Plaintiff also has admitted that the "hardware or structural means of implementing the concepts" presented in his paper which "discloses the 'directional computer' *without disclosing hardware or structure*" "are sufficiently taught in plaintiff's [prior art] patent 2,923,465 issued February 2, 1960." [*Id.* at ¶ 17 (emphasis added)].

Every invention works only because the "laws of nature" permit it to do so. Accordingly, to irrefutably presume *knowledge* of all laws of nature by those skilled in the art would be tantamount to presuming knowledge of the very reasons why the invention works. Once these *reasons* are presumed to be known to those skilled in the art, however, the invention will almost invariably be obvious to them.

In addition to rendering almost every worthwhile invention obvious, application of defendant's theory would discourage inventors in the future from disclosing the principles behind the operation of their inventions, fearing that such disclosure would be used against them as a mere use of a "principle of nature" to destroy the patentability of their inventions. The result would be a severe frustration of the very purpose of the patent system.

Thus, the *obviousness* of the invention must be judged against only that which was, in fact, *known*—nothing more. The cases defendant has cited in support of its position[28] are, in our opinion, of little relevance. Not only were they all decided before the statutory test of "obviousness" was enacted,[29] but a close analysis of each reveals that the courts were really addressing the question of whether the inventions under consideration were the kind of inventions to which Congress intended to afford patent

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[28] Defendant relies upon *Funk Bros. Seed Co. v. Kalo Co.*, 333 U.S. 127, 76 USPQ 280 (1948); *Davison Chemical Corp. v. Joliet Chemicals*, 179 F.2d 793, 84 USPQ 325 (7th Cir. 1950); and *Loew's Drive-In Theatres, Inc. v. Park-In Theatres*, 174 F.2d 547, 81 USPQ 149 (1st Cir. 1949).

[29] The standard of "obviousness" was first expressed as a statutory requirement in § 103 of the 1952 Patent Act. Prior to this time, there was considerable confusion among the courts as to the proper test to be applied. Some courts examined the simplicity of the invention, others its manner of discovery, and others merely their own personal expertise.

protection,[30] not whether they were obvious over the prior art. Accordingly, defendant's motion for summary judgment of invalidity based on the two assertions discussed above is denied.

V. Infringement

Plaintiff has moved for summary judgment on the issue of infringement alleging that claims 2, 3, 6, and 7 are infringed by the guidance system manufactured by Lockheed for defendant and used by defendant in the Poseidon missiles and proposed for use in the Trident missiles. Although the question of infringement becomes moot if the claims in suit are invalid, we have, nevertheless, given consideration to the infringement issue at this time for the sake of judicial economy in the event the holding of invalidity is not sustained. We begin by considering first the Poseidon missile.

A. *Application of Claim 2 to Poseidon*[31]

1. *Element (c) of Claim 2*[32]

Element (c) of claim 2, in essence, calls for means to calculate $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt$, where $\mathbf{Y}$ is an input vector, $\mathbf{b}$ is an output vector, and the integration is relative to a space

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[30] For example, in *Funk Bros.*, *supra* at n. 28, the Court stated that they could not sustain the patent's validity "without allowing a patent to issue on one of the ancient secrets of nature now disclosed," *Id.* at 132, 76 USPQ at 282, a statement which implies to us that the patent was not drawn to the type of invention which Congress intended to be susceptible to patent protection—a requirement which is now embodied in § 101 of the Patent Act. Indeed, the Supreme Court has just recently relied heavily on *Funk Bros.* in determining the proper scope of § 101. *See Parker v. Flook*, 437 U.S. at 591, 198 USPQ at 198.

[31] Claim 2 is presented in full in Appendix A, *infra*.

[32] The portion of claim 2 identified as "element (c)" is presented in full, *supra*, at p. 42a.

stabilized reference frame.[33] Plaintiff claims that the computer on-board the Poseidon missile infringes this element twice by performing, at different points in time, the following two computations: (a) $\mathbf{P} = \int \omega \times \mathbf{P}\, dt$, where ω is the input vector which generates $\mathbf{P}$, $\mathbf{P}$ is used to produce the missile's steering commands, and the integration is performed relative to a space stabilized reference frame; (b) $\mathbf{U_S} = \int K_{S1}\mathbf{U_S} \times (\mathbf{U_{SF}} \times \mathbf{U_S})\, dt$, where $\mathbf{U_{SF}}$ is a "trajectory shaping vector read in from fire control," $\mathbf{U_S}$ is used to prescribe the flight path of the missile, and the integration is performed in relation to the missile's space stabilized reference frame.

With respect to the first computation (a), plaintiff interprets the claimed output vector, **b**, to encompass the accused steering command, **P**, and the claimed input vector, **Y**, to encompass the accused input vector, ω. Although this does not result in absolute identity between the two computations even when the above identities are incorporated in the accused computation (because the accused computation incorporating the alleged identities merely becomes $\mathbf{b} = \int \mathbf{Y} \times \mathbf{b}\, dt$, whereas the claimed computation $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt$), plaintiff contends that the claimed computation is nevertheless literally infringed by the accused computation incorporating the alleged identities.[34]

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[33] By saying that "the integration is relative to a space stabilized reference frame," we adopt the inventor's definitions as set forth in his specification, namely, the vector quantities of the integrand, *i.e.*, **b** and **Y**, are expressed in reference to the stabilized reference frame. *See* cols. 4 and 5, lines 64–75 and 1–4, respectively.

[34] At first, it might appear that the two are identical since the product of a first *scalar* quantity times a second *scalar* quantity is always equal to the product of the second times the first (*i.e.*, AB = BA). However, it must be remembered that when an "×" is placed between two *vector* quantities, it is deemed to connote the mathematical operation called "cross product," not

In its reply, defendant does not deny that the claimed computation reads on the first accused computation (a). *See* DRSPOL § 119. Defendant does, however, maintain that the accused *apparatus* does not perform the accused computation and, therefore, that the accused *apparatus*, which is the sole subject of this infringement suit, does not infringe element (c) of claim 2. Specifically, defendant contends that a portion of the claimed computation (the mathematical operation of integration) can be performed only by an analog computer (which is what plaintiff discloses in his specification to perform the integration), and that the accused structure, being a digital computer, does not and *cannot* perform this operation. To resolve this issue, we must examine the type of computation actually performed by defendant's digital computer and then compare it with the claimed computation.

"multiplication," and the cross product between a first vector and second vector quantity does not equal the cross product between the second and the first (*i.e.*, $\mathbf{A} \times \mathbf{B} \neq \mathbf{B} \times \mathbf{A}$).

Nevertheless, plaintiff's result can be justified as follows:

1) Although $\mathbf{A} \times \mathbf{B} \neq \mathbf{B} \times \mathbf{A}$, it is well known that $\mathbf{A} \times \mathbf{B} = -\mathbf{B} \times \mathbf{A}$. See Shames, *Engineering-Mechanics*, § 2.7 (1960). Therefore, the accused $\omega \times \mathbf{P}$ is equivalent to $-\mathbf{P} \times \omega$.

2) Using the definition of cross product, *see* background mathematics discussion, *infra* at Appendix B, it can be shown that $-\mathbf{B} \times \mathbf{A} = \mathbf{B} \times -\mathbf{A}$. Therefore, the accused computation $\omega \times \mathbf{P}$ is also equal to $\mathbf{P} \times -\omega$.

3) If Y is equated to minus the accused input vector ω (*i.e.*, $\mathbf{Y} = -\omega$), instead of the input vector itself (*i.e.*, $\mathbf{Y} = \omega$), then the identity between the claimed computation and the accused computation is easily seen:

$$\begin{aligned} \int \omega \times \mathbf{P}\, dt &= \text{accused computation} \\ &= \int -\mathbf{P} \times \omega\, dt \quad \text{[under (1) above]} \\ &= \int \mathbf{P} \times -\omega\, dt \quad \text{[under (2) above]} \\ &= \int \mathbf{b} \times \mathbf{Y} dt \quad \text{[incorporating the alleged identities]} \\ &= \text{claimed computation.} \end{aligned}$$

Integration, as we have pointed out in the background mathematics discussion, *infra* at Appendix B, is essentially a "continuous" method of calculating and summing an infinite series of mathematical computations. Analog computers include devices known as electronic analog integrators which perform this integration operation. These electronic analog integrators operate very much like the "bucket integrators" which we discussed during our discussion of background mathematics, *infra* at Appendix B. When electronic analog integrators are used to integrate a time-varying quantity, the time-varying quantity is first converted into an electronic signal having a time-varying strength proportional to the magnitude of the time-varying quantity, and this electronic signal is then fed to the electronic analog integrator which accumulates the electronic current flow resulting from the electronic signal in very much the same way as did the "bucket integrator" in our water hose and bucket example.

The digital computer, on the other hand, *cannot* perform the continuous process which the electronic analog integrator and the "bucket integrator" perform and, therefore, can never *truly* integrate. Instead, the digital computer is programmed to *approximate* the results of an actual integration by taking periodic samples of the time-varying quantity and calculating from this an approximated value for the integral using a computation process either identical to, or similar to, the sample method illustrated in the background mathematics discussion in Appendix B, *infra*. Just as in that example, however, the accuracy of the result achieved by the digital computer using the sample method can be made as accurate as necessary merely by increasing the frequency of the samples. The integral, however, can never be precisely calculated by the digital computer.

Thus, although it is true that the digital computer does not and cannot perform integrations, as such, defendant's digital computer has been programmed to perform a series of discrete mathematical computations

designed to *simulate* actual integration, and the results of that simulation *approximate* the results of an actual integration as closely as needed. If an apparatus has been intentionally designed to *simulate* an integration, we do not think that it avoids infringement of a portion of a claim which is directed to all means which perform that integration.

First of all, although the specification discloses only analog integrators to perform the integration, the claim is not limited to any specific type of apparatus for performing the integration. As we have pointed out in our discussion of the validity of claim 2, although the specification may be properly used to *interpret* limitations *already* present in the claims, *Westwood Chemicals v. United States*, 207 Ct. Cl. 791, 525 F.2d 1367, 187 USPQ 656 (1975), they may never be used to impose additional or otherwise nonexistent limitations upon those claims, *Siegler v. Watson*, 267 F.2d 621, 121 USPQ 119 (D.C. Cir. 1959). Moreover, there is nothing in the prior art or the file wrapper of the '052 patent which would require the claims to be limited to such a narrow interpretation.

A similar case was before this court in *Decca Ltd. v. United States*, 210 Ct. Cl. 546, 563–64, 544 F.2d 1070, 1079–80, 191 USPQ 439, 447 (1976), where the court rejected defendant's contention that the scope of the claim must be limited to analog computers because that was the only type computer disclosed in the specification:

> With respect to the contention that use of digital means distinguishes the accused system, it is to be noted that the claim is not by its terms, in any way limited to the specific analog mechanism disclosed. Also, the specification contains no indication that it was the configuration or details of the particular apparatus disclosed that was considered by the patentees to be their invention. Nor is there either prior art which requires that the claims be limited to the apparatus disclosed in order to preserve its validity, or proof that the doctrine of file wrapper

> estoppel requires such a limited construction of the claims. On these facts, infringement is not avoided by showing that digital instead of analog techniques are used in the accused system.

Thus, whether the accused apparatus is digital or analog is irrelevant to the question of infringement under the facts of this case. The essential question is whether the accused apparatus responds to the limitations stated in the claims. We now focus our attention on this question.

We first note that an "integrator" is *not* called for as an element of claim 2. Rather, the claim merely recites "means" to express an output vector "as the integral" of another quantity. Thus, *any* means which expresses an output vector as the integral of that other quantity, be it an integrator or equivalent means, infringes this portion of the claim.

Secondly, when we interpret the meaning of the claim language in light of the specification, it becomes clear that the "means" which expresses an output vector as the integral of another quantity need not do so *precisely*. Were that not the case the claim would not even read on the disclosed preferred embodiment, for electronic analog integrators cannot calculate the integral *precisely* due to intrinsic electronic errors such as drift and offset, neither of which can be entirely eliminated. Indeed, the results achieved by defendant's high-speed digital computer programmed to *simulate* integration may *approximate* the integral more accurately than the results achieved by the rudimentary analog integrator disclosed in the patent specification.

Thus, when the claim language is read in light of the specification, *all* means which are capable of expressing an output vector *approximately* as the integral of the cross product between the output vector and the input vector infringe element (c) of claim 2. As a consequence of this interpretation, we conclude that the first computation (a) performed by the digital computer on board defendant's

Poseidon missile comes within the scope of the claim both literally and substantially.

Even assuming, *arguendo*, that a case of literal infringement is not established, defendant's digital computer may still infringe element (c) of claim 2 under the judicially created doctrine of equivalents if it performs substantially the same function of the patented device, in substantially the same way, to obtain substantially the same result, *see Graver Tank & Manufacturing Co. v. Linde Air Products Co.*, 339 U.S. 605, 608, 85 USPQ 328, 330 (1950).

Although there is no question that the digital computer performs substantially the *same function* to obtain substantially the *same result*, defendant contends that it does not perform in substantially the *same way*. Specifically, defendant maintains that the digital computer simulation of integration is wholly unlike the actual integration process called for by the claim. However, as we have concluded in our discussion of integration, the sample method used by the digital computer to simulate actual integration is very much like the actual integration process itself. It differs in that the time period of measurement is microfinite rather than infinitesimal, a difference which in our minds is insufficient to legally distinguish the use of a digital computer from the "means" broadly encompassed by the claim language.

What is perhaps most significant to this question is the fact that this is *not* a case where an apparatus is accused of performing a function which merely accidentally is similar to a claimed function, but a case where the apparatus is *intentionally designed* to simulate that function. As proof of this, one need only look at the manual which describes the operation of defendant's Poseidon missile. A chart in the manual shows a number of "Steering Equations" which expressly include the mathematical symbol for integration, "$\int$". *See* plaintiff's exhibit no. 23 (filed February 27, 1978). Defendant cannot program a digital computer to *simulate* integration

and then say that the programmed digital computer does not perform an operation *equivalent* to integration. Accordingly, we conclude that, even if not literally infringed, under the doctrine of equivalents defendant's digital computer, being programmed to simulate the first computation (a), is encompassed by the terminology used to define element (c) of claim 2 and, to that extent, infringes that claim.

With respect to the second computation (b), plaintiff interprets the claimed output vector, $\mathbf{b}$, to encompass the accused flight path control vector, $\mathbf{U}_S$, and the claimed input vector, $\mathbf{Y}$, to encompass K_{S1} times the cross product between the accused trajectory shaping vector, $\mathbf{U}_{SF}$, and the accused flight path control vector, $\mathbf{U}_S$ (*i.e.*, $\mathbf{Y} = K_{S1}(\mathbf{U}_{SF} \times \mathbf{U}_S)$).[35] When these identities are incorporated into the accused computation, it becomes identical with the claimed computation.[36]

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[35] That the scope of the claimed input vector, $\mathbf{Y}$, is broad enough to encompass $K_{S1}(\mathbf{U}_{SF} \times \mathbf{U}_S)$ is demonstrated by just such an identity in the specification. Specifically, the specification states that: "Since the input vector $\mathbf{Y}$ is open to choice, it can be stated as: $\mathbf{Y} = \mathbf{Z} \times \mathbf{b}$ where $\mathbf{Z}$ is a given vector," col. 2 lines 44–46, and "$\mathbf{Z}$ [may be] expressed as: $\mathbf{Z} = \alpha\mathbf{g}$," col. 4, lines 10–11. Thus, the specification states that $\mathbf{Y} = \mathbf{Z} \times \mathbf{b} = (\alpha\mathbf{g}) \times \mathbf{b} = \alpha(\mathbf{g} \times \mathbf{b})$ which is of the same form as $K_{S1}(\mathbf{U}_{SF} \times \mathbf{U}_S)$.

[36] Actually, the accused computation is not directly susceptible to incorporation of the alleged identities because the identity for $\mathbf{Y}$, (*i.e.*, $K_{S1}(\mathbf{U}_{SF} \times \mathbf{U}_S)$) does not appear directly in the accused computation. Nevertheless, the accused computation can be easily manipulated into a form susceptible to the incorporation of the alleged identities. The following manipulation is all that is needed:

$$\begin{aligned} \int K_{S1}\mathbf{U}_S \times (\mathbf{U}_{SF} \times \mathbf{U}_S)dt &= \text{accused computation} \\ &= \int \mathbf{U}_S \times K_{S1}(\mathbf{U}_{SF} \times \mathbf{U}_S)dt \\ &= \int \mathbf{b} \times \mathbf{Y}dt \quad \text{[incorporating the alleged identities]} \\ &= \text{claimed computation.} \end{aligned}$$

In defendant's reply to this allegation, although he does not dispute that the claimed computation is infringed by the second accused computation, *see* DRPOL ¶ 119, defendant does maintain the same defense that he did with respect to the first accused computation (a) *i.e.*, that the accused apparatus, a digital computer, does not and cannot perform the second accused computation (b). We, however, maintain the same conclusion here that we did with respect to the first accused computation (a), namely, that such a distinction is without legal significance under the facts of this case and conclude, therefore, that defendant's digital computer programmed to *simulate* computation (b) also infringes element (c) of claim 2.

2. *Element (a) of Claim 2*

The expression of a vector quantity must always be in reference to a frame of reference to give that expression meaning. *See* Appendix B, *infra*. The purpose of element (a) of claim 2[37] "a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity," is to serve as this frame of reference.

"[A] physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity" is a specific type of reference frame known as a "space-stabilized" reference frame. A "space-stabilized" reference frame is a reference frame which maintains a constant angular position relative to space even though the angular position of its supporting harness may change relative to space.

One technique used to "space-stabilize" a reference frame, the technique called for by claim 2, is to use "means of sensing and suppressing its angular velocity." What this means is that "means" are connected to the reference frame which sense its rotational movement relative to space (*i.e.*, its "angular velocity") and, in response to the sensed rotational movement, suppress

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[37] The full text of claim2 is presented in Appendix A, *infra*.

that movement by rotating the reference frame back to its original position relative to space. Thus, although the "space-stabilized" reference frame may be mounted within a rotating structure (such as a missile rotating about its trajectory axis), the angular position of the "space-stabilized" reference frame relative to space will not change.

Defendant has tacitly conceded that the vector quantities used in the Poseidon missile computations discussed above are referred to a space-stabilized reference frame (*see* PMSJ at p. 8 and DRPMSJ at p. 43), and that this reference frame is defined by a mutually orthogonal set of reference axes labeled sr, j, and sv (*see* PSPOL and DSPOL at ¶ 2, 13, and 21). Defendant denies, however, that the reference frame defined by axes sr, j, and sv are "physically defined" within the meaning of that language as used in element (a) of claim 2 and, therefore, denies that this element is infringed by the Poseidon missile. Rather, defendant states that "it is more satisfactory to consider the reference frame [defined by axes sr, j, and sv] as a mental picture rather than a physical object." (DSPOL at p. 5.)

To support its contention that the space stabilized reference frame defined by axes sr, j, and sv is physically defined, plaintiff relies upon a description of defendant's Poseidon missile contained in a Poseidon missile teaching manual, PL-EX 22. In this manual, plaintiff first points to language allegedly showing that the Inertial Reference Subsystem, a component of the Poseidon missile, is "a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity":

> 3.2.1 (U) INERTIAL REFERENCE SUBSYSTEM. The basic function of the inertial reference subsystem, figure 3-4, is to provide a *stable platform* for the acceleration measurement subsystem and to provide a reference platform for missile attitude control. As shown in figure 3-4, the inertial reference subsystem comprises three gyros, three gyro output

> amplifiers (in one module), a gyro error resolver, three gimbal servo modules, five torque motors, three tachometers, and three gimbals. *The three gyros on the gimbal-mounted stable platform provide error signals indicating angular displacements of the platform with respect to inertial space.* The error signals are amplified by the gyro output amplifier and the gimbal servo modules and *the amplifier outputs are used to drive the gimbal torque motors to null the platform angular displacement.* [PL-EX 22 at Change 2, Rev. 1, p. 3-3 (emphasis added)].

Plaintiff apparently equates the "stable platform" with "a physically defined, stabilized reference frame" and the means for "indicating angular displacement of the platform with respect to inertial space" and the means to "null the platform angular displacement" with the "means of sensing and suppressing [the reference frame's] angular velocity."

To demonstrate that the axes sr, j, and sv are physically defined, plaintiff points to the portion of the manual which states:

> The acceleration measurement [using the stable platform of the Inertial Reference Subsystem] is accomplished by three pulsed integrating pendulous accelerometers (PIPA's) *mounted on* the computing *axes (sr, j, and sv).* [PL-EX 22 at Change 7, Rev. 1, p. 2-4 (emphasis added)].

Plaintiff argues that this language demonstrates that the sr, j, and sv axes are *physically* defined for it is not possible to "mount" an accelerometer on a "mental picture."

As further evidence of the physically defined nature of axes sr, j, and sv, plaintiff brings to the attention of the court the following passage from the Poseidon missile manual:

> The function of the acceleration measurement subsystem, figure 3-5, is to measure changes in velocity

> in terms of the components of velocity along the slant range (sr), slant vertical (sv), and crossrange (j) axes. [*Id.* at change 2, Rev. 1, p. 3-3.]

The significance of this statement, as plaintiff has pointed out, is that the acceleration measurement subsystem, a piece of hardware, measures *physical* changes in the [velocity] of the sr, j, and sv axes, measurements which could not be made upon a "mental picture."

Finally, plaintiff quotes the following language from the Poseidon missile manual to further demonstrate that the sr, j, and sv axes must be physically defined:

> Dual windings of the gyro signal generator [a part of the Inertial Reference Subsystem] provide components of sr, sv, and j axis rotations. [*Id.*]

Plaintiff contends that the gyro signal generator can only generate rotation measurements of the sr, j, and sv axes if those axes are *physically defined*, for a piece of hardware cannot be used to measure the rotation of a "mental picture."

We think that this evidence is sufficient to demonstrate that the space stabilized reference frame defined by axes sr, sv, and j in the Poseidon missile is *physically* defined insofar as it is embodied in the acceleration measurement subsystem.

To support the contrary position that Poseidon's reference frame is merely a "mental picture," defendant has not offered a single piece of evidence. Moreover, defendant has not even offered the slightest explanation of what defendant means by a "mental picture," how it is created, how an accelerometer and a gyro signal generator can measure physical attributes of the "mental picture," or how an accelerometer can be "mounted on" the purported "mental picture." Indeed, in the entire record to date, the only statement made by defendant concerning the sr, sv, and j axes, if anything, supports plaintiff's contention that these axes are *physically* defined. Specifi-

cally, in response to plaintiff's contention that the axes were physically defined, defendant stated:

> Though it is true that the accelerometers are mounted with their sensitive axes close to the SR, J and SV axes, the measurement of misalignments between the accelerometer sensitive axes and the SR, J and SV axes clearly indicates the distinction between these two. [DRPOL, ¶ 2.]

Although defendant offered no evidence to support its statement that a "measurement of misalignment between the accelerometer sensitive axes and the SR, J and SV axes" was made in the Poseidon missile system, even assuming the statement to be accurate, as plaintiff has pointed out, it does not support the theory that these axes are *not* physically defined:

> Defendant rightly speaks of the "*measurement* of misalignments *between* the accelerometer sensitive axes and the SR, J and SV axes . . . ." The misalignments exist and are measurable exactly because the axes SR, J, and SV exist as independent, physical entities. [PRSPOL, ¶ 2, emphasis added.]

This court is well aware that a motion for summary judgment may not be granted where a genuine issue of material fact is in dispute, *see e.g.*, *Nicholas A. Garcia, Jr. v. United States*, 123 Ct. Cl. 722, 732 (1952). However, once a moving party has introduced sufficient evidence to support his allegation, the burden of proceeding shifts to the opposing party and a mere formal denial unsupported by evidence or even explanation is wholly insufficient to place such issue of material fact in dispute and, therefore, is insufficient to prevent the award of summary judgment. *See Royal Indemnity Co. v. United States*, 178 Ct. Cl. 46, 371 F.2d 462, *cert. denied*, 389 U.S. 833 (1967). Accordingly, because we believe that the evidence offered by plaintiff is sufficient to demonstrate that the space reference frame defined by axes sr, sv, and j is physically defined, and because defendant has done nothing more

than merely deny this fact, we conclude that element (a) of claim 2 is infringed by defendant's Poseidon missile.[38]

3. *Element (b) of Claim 2*

The last element of claim 2,[39] element (b), calls for "means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector." While defendant appears to admit that its Poseidon missile has a similar type of means, defendant contends that, for some of these vector quantities, the "representation [of them in the Poseidon missile] is quite unlike that of plaintiff's vectors. They take part in a series of computations performed by a general purpose digital computer." DRPMSJ, p. 43. What defendant appears[40] to mean by this is that the *form* of the representation of the values of the vector's coordinates in Poseidon's digital computer is different from the *form* of their representation in the analog computer disclosed in the patent specifications. However, although it is true that the *forms* of representation are different,[41] no

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[38] Even at the lengthy oral argument on the present motion, defendant was unable to satisfy the trial judge that the *facts* upon which the foregoing conclusion is based are in dispute or that defendant would adduce more or different *facts* in the event a trial was to be held on this issue.

[39] The full text of claim 2 is presented in Appendix A, *infra*.

[40] We say "appears" because defendant has again failed to adequately explain its position.

[41] The value of a vector coordinate in an analog computer is represented by a *single* electrical signal having a voltage proportional to the value of the vector coordinate. The value of a vector coordinate in a digital computer, on the other hand, is represented by a *plurality* of electrical signals having only one of two possible voltages depending on the value of the vector coordinate. This latter form of representation is known as a "digital" representation while the former is known as an "analog" representation. (continued)

particular form of vector coordinate representation is specified in the claim and their is nothing in the prior art or in the prosecution history of the patent which would require the scope of the *claims* to be limited to the particular *form* disclosed in the patent *specifications*. As we have already pointed out, although the specification may be properly used to *interpret* limitations already

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While the representation of the value of a vector coordinate in analog form may be intuitively appreciated, its representation in digital form may be appreciated only after the nature of a "digital" signal is understood.

A "digital" signal derives its name from the fact that the signal is representative of a *digit*, whereas an "analog" signal is representative of a *value*. The difference is illustrated by the following example: If the *value* of a vector coordinate were 7214, this could be represented by a single "analog" signal having a voltage proportional to the *value* of that coordinate (*e.g.*, the "analog" signal might be 7214 volts). On the other hand, because a "digital" signal can only represent *digits*, it would take a set of four "digital" signals to represent the *value* of the vector coordinate (*i.e.*, one "digital" signal for each *digit* of the *value*).

The nature of "digital" signals is further distinguished from "analog" signals in that a "digital" signal is commonly capable of representing *only* the digits "1" or "0". Thus to represent the value of a vector coordinate by a "digital" signal, the value must first be expressed only in terms of "1s" or "0s". This merely requires the conversion of the value from its base 10 decimal form (the base we normally think of) into a base 2 binary form, a problem easily solved using elementary mathematics. The voltage of the "digital" signal is then normally set to a high level if the digit to be represented as a "1" or to a low level if the digit to be represented is a "0".

Thus, in the above example the digital representation of the vector coordinate value 7214 (which in "binary" equals 1110000101010) would require 13 electrical signals (one for each binary digit) set to the appropriate voltage level. This is contrasted to the single electrical signal which might be set to 7214 volts to represent the value in an analog computer.

present in the claims, *Westwood Chemicals, Inc. v. United States*, 207 Ct. Cl. 791, 525 F.2d 1367, 187 USPQ 656 (1975), the specification may never be used to *add* other or otherwise nonexistent limitations to those claims, *Siegler v. Watson*, 267 F.2d 621, 121 USPQ 119 (D.C. Cir. 1959). Accordingly, we conclude that the Poseidon missile infringes element (b) of claim 2.

Having concluded that defendant's Poseidon missile infringes each and every element of claim 2, plaintiff's motion for summary judgment for infringement of claim 2 by defendant's Poseidon missile is granted.

Claim 3[42] is similar to claim 2 except that it defines the axes of the "physically defined, stabilized reference frame" to be "denoted by the numerals **1**, **2**, and **3**" and calls for "means of obtaining an input signal . . . being referred to said axis **3** to express an input vector." Plaintiff contends that because this language fails to state anything about the other two components of the input vector, *i.e.*, Y_1 and Y_2, claim 3 is broader than infringed claim 2 and therefore *a fortiori* infringed by defendant's Poseidon missile. Defendant, on the other hand, contends that claim 3 implicitly requires that two of the components of the input vector, *i.e.*, Y_1 and Y_2, must be consistently zero and that, since the Poseidon missile does not operate this way, it does not infringe claim 3. For the following reasons, we agree with defendant:

A portion of the language in claim 3 states that while the computation $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt$ is being performed, the "output vector is driven by the said input vector to rotate around the said axis **3**." However, because the output vector, **b**, always rotates around the input vector, **Y**, whenever this computation is performed,[43] the input

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[42] The full text of claim 3 is presented in Appendix A, *infra*.

[43] Plaintiff has stated that all of the claims in suit "cover every functional result that is producible in an output direction." Plaintiff's Answers to Defendant's Interrogatories, ¶ 4b, 5 (filed June 21, 1976). These "functional results" are described in the

vector, **Y**, must be in coalignment with axis **3**. This can only happen, however, when the components of the input vector, **Y**, along axes **1** and **2** are constantly zero. Therefore, the language of claim 3 requires by implication that two of the three components of the input vector be of zero value.

This conclusion is fortified by the fact that our interpretation of the claim is supported in the specification by the following language:

> If, also, by the nature of the input vector in the particular reference frame utilized, one or two of the input vector components are consistently zero, all the computations regarding them in that reference frame go out. [Col. 9, lines 30–34.]

Moreover, no language could be found in the specification which supports plaintiff's interpretation of the claim language. Accordingly, because plaintiff has not demonstrated that two of the three input vector components are *consistently* zero in defendant's Poseidon missile, plaintiff's motion for summary judgment for infringement of claim 3 by defendant's Poseidon missile is denied.

The parties agree that claim 6[44] is identical to infringed claim 2, except for the following additional elements:

> (d) a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween,

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specifications. One is that "the output [vector] rotates *around* the input vector to describe a conical surface" and the other is that "the output [vector] rotates *directly towards* the input vector and *seeks coalignment*" (which by implication means that it must rotate *around* the input vector until it becomes coaligned) col. 1, lines 21–32. Thus, the output vector always rotates *around* the input vector during performance of the claimed computation.

[44] The full text of claim 6 is presented in Appendix A, *infra*.

(e) the input signals being referred to the second reference frame to express an input vector, and

(f) the "means" receiving the input signals and generating the output signals to include the coordinate transformation means in (d) above. [*See* PRDRA at ¶ 21.]

To support plaintiff's contention that the Poseidon missile also infringes claim 6, plaintiff brings to the attention of this court the following language in the Poseidon missile manual:

> *These signals* [making up vector **P**] *are* converted from digital to analog, *coordinate transformed*, and multiplexed in flight control. *They are coordinate transformed again* by the coordinate transformation resolver chain, and used by flight control to control missile attitude. **P** vectors are used throughout the flight. [PL EX 22 at Rev. 1, p. 2-2 (emphasis added)].

Defendant's sole opposition to this allegation is that:

> [S]ince this [allegation] builds on [the allegation that claim 2 is infringed by the Poseidon missile] with which we disagreed, we disagree with this [allegation]. [DRSPOL at ¶ 41.]

It is clear, therefore, that defendant does not contend that Poseidon does not infringe claim 6 because it lacks the additional elements of claim 6 not found within claim 2. Rather, defendant's sole opposition to an allegation of infringement is based on its contention that the Poseidon missile lacks the elements of claim 6 common to claim2, or in other words, that the Poseidon missile does not infringe claim 2. In view of our contrary ruling on this point, however, plaintiff's motion for summary judgment for infringement of claim 6 by defendant's Poseidon missile is, therefore, granted.

Claim 7[45] is identical to claim 6 except that it incorporates the same language which distinguished claim 3 from claim 2. Accordingly, for the same reasons we failed to find claim 3 infringed by defendant's Poseidon missile, we find claim 7 also not infringed and, therefore, deny plaintiff's motion for summary judgment for infringement of claim 7 by defendant's Poseidon missile.

In summary, based upon our interpretation of the claims and the evidence submitted by the parties relating to the accused Poseidon missile, we have concluded that plaintiff's motion for summary judgment for infringement by defendant's Poseidon missile should be granted with respect to claims 2 and 6, but should be denied with respect to claims 3 and 7.

B. *Application of the Claims to Trident*

Evidence on the structure of defendant's Trident missiles, on the other hand, has not been introduced due to classification encumbrances. Nevertheless, the parties have stipulated that, for the limited purpose of this suit, the structural portions of the Trident missile relevant to the question of infringement are identical or equivalent to the corresponding structural portions of the Poseidon missile.[46] Accordingly, plaintiff's motion for summary

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[45] The full text of claim 7 is presented in Appendix A, *infra*.

[46] The equations implemented on the Poseidon missile which we have previously analyzed were copied from page 2-87 of document LMSC-D-052305. The corresponding equations implemented on Trident, however, were considered by defendant to be classified and, therefore, not subject to examination in open court. Plaintiff, however, contended that this information was not properly subject to classification, but advised defendant that the dispute could be settled if the Government would stipulate that the Trident missile implements these equations identically or equivalently as Poseidon. In response to this request, Admiral Levering Smith wrote a letter to the Chief of Naval Research on August 9, 1977, stating: "Mr. Arshal advised that if the government will validate the fact that the

judgment for infringement by defendant's Trident missile is also granted with respect to claims 2 and 6, but is also denied with respect to claims 3 and 7.

VI. *Summary and Conclusion*

While most courts are reluctant to grant summary judgment in patent cases involving technically sophisticated subject matter, *see e.g., Xerox Corp. v. Dennison Manufacturing Co.*, 332 F. Supp. 963, 966–67, 168 USPQ 700, 703 (S.D.N.Y. 1971), it is well established that summary judgment is permissible when the court can understand the relevant technology without the aid of expert opinion, *see e.g., Grayson v. McGowan*, 543 F.2d 79, 192 USPQ 571 (9th Cir. 1976). In the present case, the voluminous body of instructional materials offered in evidence by both parties, the helpful comments offered at the extensive and thorough oral hearing on the motions, and this court's substantial experience with patent law cases, has enabled the court to sufficiently comprehend the subject technology to render a technically sound decision without hearing the testimony of technical expert witnesses.

Our analysis of the claims in suit and the accused structures has led us to conclude that, although claims 2 and 6 are infringed by defendant's Poseidon and Trident

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TRIDENT missile system implements these equations identically or equivalently as POSEIDON the debate over classification will have been ended. . . . [O]ur determination meets the request of Mr. Arshal . . . ."

Then, in plaintiff's brief supporting its motion for summary judgment (filed April 7, 1978) plaintiff stated that Admiral Levering Smith's letter was "intended to satisfy plaintiff's request for a stipulation that 'validate[s] the fact that the Trident missile system implements these steering equations identically or equivalently as Poseidon'." Because defendant's reply brief (filed May 18, 1978) did not dispute this alleged stipulation, we have concluded that defendant does not disagree with it.

missile systems, all of the claims in suit fail to define an invention which is susceptible to patenting under 35 U.S.C. § 101 and are, therefore, invalid. In view of this finding, we have decided that it is unnecessary to rule on plaintiff's motion for summary judgment on the license issue or other issues raised by either party.

For the reasons set forth herein, defendant's motion for summary judgment on the dispositive issue of invalidity is allowed, and plaintiff's motion for summary judgment on the issue of infringement is allowed as to claims 2 and 6, if not moot, and is denied as to the issue of validity. The petition is dismissed.

APPENDIX A and APPENDIX B

These appendices are identical with those of Appendix 3 at pages 27a and 29a.

APPENDIX 5

United States District Court
Western District of Washington

NO. C97–472C

(Filed: March 26, 1997)

GEORGE ARSHAL,

Plaintiff,

v.

JOHN H. DALTON, Secretary of the Navy,

Defendant.

COMPLAINT
(Jury Demand)

1. Plaintiff resides in King County at 124 South 339th Circle, Apt. C, Federal Way, Washington 98003.

2(a). This action is based on innumerable violations of due process in a patent infringement suit that plaintiff prosecuted against the United States Navy in the former United States Court of Claims. The violations of due process include perjury, libel, fabricated evidence, falsified evidence, disregard of evidence, fraudulent distortions, and flagrant violations of patent law. They were used by the court to invalidate perfectly sound patent claims that were found to be infringed. These unlawful acts are specifically alleged hereinafter. They render the decision of the Court of Claims unconstitutional and invalid.

2(b). It follows that plaintiff held proprietary rights in an invention that was taken for the United States Navy without just compensation. This unconstitutional possession is maintained in the person of the Secretary of

the Navy. Accordingly, money damages are claimed against him in order to redress the matter. However, the constitution obligates the Government to pay those damages. Therefore, the suit against the Secretary of the Navy applies as one against an officer acting unconstitutionally under color of legal authority, but it holds him harmless. The suit is "in reality against the Government."

2(c). This Court has jurisdiction over this action under the following authorities: Amendment 5 of the Constitution of the United States; 28 USC §§ 1331 and 1391(e); *Davis v Passman*, 442 US 228, 60 L Ed 2d 846, 99 S Ct 2264; *Stafford v Briggs*, 444 US 527, n. 6 at 536, 539, 542, n. 10 at 542, 546, 63 L Ed 2d 1, 100 S Ct 774; *Larson v Domestic and Foreign Commerce Corp.*, 337 US 682, 696–697, 93 L Ed 1628, 69 S Ct 1457; and *United States v Lee*, 106 US 196, 215–218, 27 L Ed 171, 1 S Ct 240. Therewith, plaintiff demands a trial by jury.

3(a). Plaintiff received U.S. Patent No. 3,319,052 (hereinafter called the '052 patent or the '052 invention) on May 9, 1967. The patent describes and claims a "Directional Computer" in various embodiments for use in flight control systems. In 1969, plaintiff notified the U.S. Department of the Navy that its Poseidon ballistic missiles infringed on claims 2, 3, 6, and 7 of this patent and pursued an administrative action with the Navy. These negotiations failed and on Dec. 12, 1975, plaintiff filed suit in the U.S. Court of Claims (Case No. 431–75, *Arshal v United States*) to recover compensation for the Government's unauthorized use of the '052 invention. About this time, the infringement of the '052 patent had advanced to the Trident I ballistic missiles of the Navy. On May 11, 1979, administrative judge Francis C. Browne,[1/] who was hearing the case, filed an Opinion on

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[1/] The Court of Claims gave the courtesy title of "trial Judge" to its adm. judges. These judges have also been called "commissioners."

motions for summary judgment finding that the Poseidon and Trident I ballistic missiles infringed on claims 2 and 6 of the '052 patent. This Opinion also found, falsely, that the claims were invalid as nonstatutory subject matter under 35 USC § 101.[2/] The finding of invalidity was subsequently ratified by Judges Shiro Kashiwa, Robert L. Kunzig, and Marion T. Bennett of the Court of Claims from a review in name only. *Arshal v United States*, 621 F.2d 421, 423 (1980).

3(b). The statements below, through par. 30(b), take note of proceedings in the former United States Court of Claims in the case of *Arshal v United States*. The term "defendant" as used in these paragraphs refers to "The United States."

4. The '052 invention is used in the flight control systems of missiles or aircraft in the following context, par. 4(a–e), which conforms to uncontroverted facts of record:

4(a). Flight control systems usually establish directional control over a kinematic quantity, such as the axis of the vehicle or the measured velocity or acceleration of the vehicle. A directional command is supplied and the vehicle is driven to eliminate any directional disparity between the command and the quantity being controlled. To be wholly useful, the command direction must be capable of providing a wide range of geometric and rate of change characteristics relative to space. It is through a progression of such command directions that a specifically desired trajectory or other flight condition is produced.

4(b). Prior to the '052 invention, the directional commands commonly referred to the gimbals of a gyroscopically stabilized reference body and commanded

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[2/] 35 USC § 101: Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

the gimbal angles.[3/] The prior art also utilized vehicle fixed gyroscopes and commanded the direction of the vehicle by means of precessing the gyros. In either case, the directional commands required a flight control response in three degrees of freedom, i.e., in pitch, yaw, and roll.

4(c). The '052 invention dispenses with angle commands and produces the directional command as a vector. In the infringed claims 2 and 6, the vector is expressed by a gyroscopically stabilized reference frame[4/] and a set of signals referred to the axes of the reference frame. The axes direct the signals and establish a resultant vector.

4(d). The command vector, which is the output vector or output direction of the directional computer, is made to receive a given input vector as its angular velocity relative to space, i.e., the output vector is rotated by an input vector. The input vector completes the concept. Different input vectors, of which several useful examples are taught in the '052 patent specification, are selectively used to generate the output vector; they generally involve navigational instruments. The output vector thus acquires the geometric or rate of change properties

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[3/] The gyroscopically stabilized reference body provides the vehicle with a space fixed reference frame. The reference body is equipped with gyroscopic measuring apparatus and is gimbal mounted for three degrees of rotational freedom. Control motors for exerting torque on the reference body are attached to the gimbals. The control motors respond to the gyroscopic measurements to suppress the angular movement of the reference body indicated by the measurements. The gimbal angles are independently determined by the orientation of the vehicle relative to the reference body.

[4/] Claims 2 and 6 represent the gyroscopically stabilized reference frame as a "physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity." This element encompasses the apparatus described in fn. 3/.

relative to space that are required to meet the guidance objectives of any particular phase of flight.

4(e). The '052 invention brought extraordinary improvements to the Poseidon and Trident I ballistic missiles:

(1) The ballistic missiles require flight controls in only two degrees of freedom. The missiles gain in simplification and performance by having to use only a single propulsion nozzle in each stage of boost flight. The single nozzle suffices because it has to support only pitch and yaw control, which it accomplishes by the pitch and yaw deflections available to it. In comparison, prior art ballistic missiles utilized a heavier and costlier system of multiple nozzles in each stage of propulsion in order to support their additional need of roll control. The multiple nozzles further degraded the missile's performance by diverting a significant amount of missile volume from propellant capacity into extra passageways for the exhaust gases.

(2) The appropriate flight control forces are readily and unconditionally defined in the frame of reference of the vehicle. The whole directional control function is executed at once through the shortest route in space and time. The prior art control systems acting under gimbal-angle commands are far removed from such speed and efficiency of performance, especially when large directional changes are required. They have to develop the gimbal angles in a roundabout, ordered sequence that correlates the control forces of the vehicle and the movement of the gimbals.

(3) The stabilized reference frame can have any known orientation relative to the earth. The gimbal-angle controls of prior-art ballistic missiles imposed a downrange alignment on the stabilized reference frame so that the pitch gimbal angle could

be positioned to direct the downrange trajectory of the missile. Aligning the stabilized reference frame downrange was time-consuming. It had to be done accurately and it had to be repeated whenever the location either of the target or the submarine was changed. The '052 invention does away with this problem. It enables rapid retargeting under a standard orientation of the stabilized reference frame.

(4) Because of said improvement 4(e)(2), independently targeted, multiple reentry warheads are deployed about three times faster than previously possible and the store of propellant required to deploy them is much reduced.[5/]

5(a). For over a year, in the early phase of the court proceedings, Admiral Levering Smith, Director, Strategic Systems Projects, refused to honor the unclassified status of a set of guidance equations, identified as "Steering Equations," which had long been declassified at the

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[5/] The deployment exercises proceed as follows: The vehicle (the last stage of the missile) is first pointed to acquire a specific velocity increment under thrust controls. The ballistic trajectory is thus reset to an assigned target. The vehicle is then reoriented to deploy the warhead for a nose first reentry into the atmosphere, which minimizes flight path dispersion through the atmosphere. The vehicle is also fine-tuned to the required velocity while it holds the deployment attitude. It then releases the warhead. The warhead is immediately spin-stabilized by small reaction motors at its base. The process is repeated for each warhead. Large attitude changes, averaging 90 degrees or more, are successively made. Solid propellant powers the entire operation. For safety reasons, submarine based missiles may not use liquid rocket fuels. Consequently, propellant is continually expended at a high rate even at times of quiescent operation involving little or no production of net force or impulse. The forces, which are produced by multiple arrays of fixed nozzles, are controlled by modulating the propellant flow between pairs of oppositely directed, collinear nozzles.

Lockheed Missiles and Space Company, the manufacturer of the Navy's ballistic missiles. Where classified documents had to be purged of classified information, Admiral Smith additionally excised the steering equations or so directed.

5(b). In June 1977, plaintiff obtained a copy of the "Steering Equations" of Poseidon as a page from an unclassified Lockheed document, LMSC/DO52305. A like document, identified as OD 43807, had wide distribution in the Navy as unclassified material since 1971. In a letter to the adm. judge on June 11, 1977, plaintiff suggested that with this unclassified information the issue of classification could end if the Government would stipulate that the Trident missile system implements the same Steering Equations as Poseidon. The adm. judge supported consideration of this proposal. The response from Admiral Smith was to consider reclassifying the unclassified "Steering Equations" on the "issue of whether the information that can be derived from the equations is classified." That tack was untenable and plaintiff forced a resolution of the matter by inserting the steering equations into submissions responding to the court's Standard Pretrial Order on Liability filed May 27, 1977. On Aug. 9, 1977, Admiral Levering Smith reversed himself:

> We have reviewed page 2-87 of LMSC/DO52305 and have determined that the filing in open court of page 2-87 of LMSC/DO52305 together with a stipulation that the POSEIDON and TRIDENT Missile Systems utilize the equations set forth therein will not violate our security regulations.

6. This resolution of the classification issue completed the documentary evidence needed to establish plaintiff's claim of infringement. It also marked the introduction of a new problem. The adm. judge, who had heretofore conducted the case fairly, embarked on a

course of outright hostility against every interest of plaintiff.

7. On or about Feb. 24, 1978, plaintiff responded to a request for admissions that was redundant, needless, and artful to begin with. On March 3, 1978, the defense counsel professed to see fault in the answers to a few of his more insidious requests for admission and moved to compel new answers to them. The adm. judge allowed this motion on March 6 before plaintiff even saw it. It was an unwarranted act of intimidation.

8. A similar, more flagrant episode quickly followed. On March 16, 1978, the defense counsel moved for an order to add new documents to the record. The documents were appended to the motion and gave "definitions" of a vector from six different publications of the counsel's choosing. The definitions were all erroneous or flawed in one way or another and conflicted with the definition of a vector in the '052 patent *specification* and *claims*. On March 20, 1978, plaintiff mailed a response opposing the motion as an intrusion on definitions already said. The adm. judge did not tolerate this response. On March 22, 1978, he ordered the defense counsel's motion and its appended exhibits, 28A through 28F, into the record. Plaintiff's response was returned *unfiled*.

9(a). On Dec. 12, 1978, the adm. judge issued an order setting Feb. 7, 1979, as the time for a hearing on pending motions for summary judgment. The order read:

> In the event an audio transcription of the oral argument is made . . . either party may have access to or make copies of the transcription.

Moreover, in preceding telephone conversations, by which the adm. judge set, canceled, and then reset the time and place of the hearing, the adm. judge expressly told plaintiff that he would mail copies of any such audio transcription to both the defendant and the plaintiff immediately after the hearing.

9(b). An audio transcription was made of the hearing in its entirety. In the week following, plaintiff did not receive a copy of the transcription and telephoned the adm. judge to ask for it. A new secretary answered the phone and resisted plaintiff's effort to reach the adm. judge, despite an explanation of the purpose. Finally, the adm. judge came to the phone and said that the audio transcription was made for his personal use and that a copy of it would not be provided or permitted to plaintiff without the defense counsel's assent.

10(a). The refusal of the adm. judge to release the transcription is related to the events of the second day of the hearing. On that day, Feb. 8, 1979, the defense counsel and the adm. judge pursued an "issue" of validity that the defense counsel had raised in defendant's motion for summary judgment (pp. 68–69). Their arguments focused on a single element of claim 2, that being element (c) as identified in the following breakdown of the claim:

> A directional computer comprising
>
> (a) a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity,
>
> (b) means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, and
>
> (c) means to receive the said input signals and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of the cross product vector between the said output vector and the said input vector,
>
> whereby the said output vector rotates around the said input vector.

The notations (a), (b), and (c) are here extraneously inserted to identify the elements of the claim. It is

noticed that element (c) makes only numerical computations, generating output signals from input signals. The element then specifies the computations, including the bookkeeping requirements to be observed in relation to the said reference frame. In speaking of element (c), and only element (c) as if it were the whole claim, the defense counsel argued that *Gottschalk v Benson*, 409 US 63, which denied patentability for a computation claimed as a method, should apply as well to element (c) which sets a computation in terms of apparatus, i.e., as "means for" a computation. The adm. judge disputed the point. He argued that *Benson* applied only to method claims and that "element (c) was a valid claim" for being drawn on apparatus. The adm. judge and the defense counsel then bandied their "differences" on the applicability of *Benson* to element (c) back and forth between themselves, over and over, throughout the morning and late into the afternoon session.

10(b). The whole proceeding was a farce. The defense counsel argued that the claim should be read for its substance, not its draftsmanship, while he was throwing out all the substance of the claim except for one element. The adm. judge joined the defense counsel in mutilating the claim but differed with him on how to read the remains. He argued for the precedence of draftsmanship over substance.

10(c). During the lunch break, plaintiff was visited by the adm. judge's law clerk. This law clerk was a new replacement. He managed to intercept plaintiff as if by happenstance during every break or recess of the hearing. On this occasion he noticed plaintiff's irritation and said: "You're mad aren't you." At the end of the conversation he admonished plaintiff as follows:

> You know, the judge is the only guy who can do you any good. You better not get him mad at you. You better go along with him.

This was fraudulent advice, as explained below in par. 11.

10(d). Plaintiff's first opportunity to speak to the court came at 3:00 P.M. Plaintiff immediately criticized the premise that element (c) was the whole claim and argued that the claim was for a *directional* computer, that it required a source of directional information, that element (a) was that source, and that element (a) could not be denied. The adm. judge rejected these points without reason or explanation. The exchanges were soon terminated. In a fit of anger, the adm. judge shouted:

"You're only making matters worse for yourself!"

On which note, the hearing ended.

11. The defense counsel and the adm. judge used the hearing of Feb. 7–8, 1979, to stage a confidence game. The adm. judge worked as the confidence man and tried to bait plaintiff into buying the line that "element (c) was a valid claim." The fact is that a patent claim is not made valid by throwing out its necessary parts. The adm. judge's argument to the contrary was a contemptible sham. It was meant only for endorsement by plaintiff so that the adm. judge might gain a legal excuse to treat element (c) as the whole claim. Subsequently, the adm. judge would have formally invoked *Benson* to invalidate the claim. That plot was thwarted when plaintiff protested the mutilation of the claim. The adm. judge then flew into a rage and threatened to make "matters worse" for plaintiff. Of course, he also denied access to the tapes of the hearing.

12. The adm. judge made good his threat to make matters worse for plaintiff in the sense: If we don't get you one way, we'll get you another way. The following paragraphs 13(a)–28 recount this development. They reflect a strategy to bring ridicule and discredit to plaintiff's handling of the case and, under cover of such injury, to falsely find the claims invalid. Acts of perjury, libel, and fraud were freely used to execute this strategy. These acts appeared all at once in the Opinion of the adm. judge.

13(a). The adm. judge's Opinion on the motions for summary judgment was filed on May 11, 1979, and produced the following vicious lie:

> Plaintiff further argues that *Benson* is inapplicable because the claims in *Benson* are drafted in the form of a "method," whereas the claims in this suit are drafted in the form of an "apparatus" (using "means plus function" language). (App. 3, 14a; App. 4, 47a.)

This is a monstrous act of perjury and libel. The adm. judge alone spoke such words and he spoke them ad nauseam on the hearing day of Feb. 8, 1979.

13(b). In another total lie, the adm. judge said:

> Plaintiff finally urges that *Benson* is inapplicable because *Benson* dealt with an algorithm used only in digital computers, whereas plaintiff's patent discloses his equation for use in analog computers. (App. 3, 15a; App. 4, 49a.)

This assertion libels the plaintiff and testifies falsely on objective facts:

(1) The "equation" is not plaintiff's equation; the equation antedates plaintiff.

(2) Computers alone, whether analog or digital, are insufficient to bring the equation into use. The equation describes the directional changes of rigid bodies in rotation (cf. par. 21(a,b)). Any real use of the equation necessarily employs a rigid body simply to gain a source of direction. Numbers in themselves are directionless.

13(c). The adm. judge also libeled plaintiff as follows:

> Plaintiff contends that his claims do not recite an "algorithm" in the *Benson* sense, but are directed to "physical geometry." (*See* plaintiff's response to defendant's motion for summary judgment under Rule 101 (filed May 3, 1978) at p. 43.) Specifically, plaintiff states that his claims are distinguishable from those in *Benson* because his are "concerned with creating a circumstance," while those in *Benson* are

concerned with "determining the value of a variable that already exists in the context of a specific set of circumstances." (App. 3, 14a; App. 4, 47a.)

The source (PRDMSJ, p. 43) that the adm. judge cited for these representations says things differently:

> In the defendant's third defense, the '052 invention is alleged to be all of the following: 1. a calculation; 2. a problem solving procedure or algorithm; 3. a preemptive mathematical formula. It stands unaccused only of being a Directional Computer.
>
> A calculation is a mathematical process of determining the value of a variable that already exists in the context of a specific set of circumstances. It has nothing to do with creating the circumstances.
>
> In contrast, the '052 invention is concerned with creating a circumstance; it does not solve for anything. Its output direction is generated on demand to produce the geometrical or rate of change characteristics that are wanted for it. The result obtained is completely anticipated. The input vector determines the output result and is selected accordingly (see par. 34–39, pages 21–22). The defendant's case citations on calculation are irrelevant.
>
> The term *algorithm* has to be accepted in the meaning of *Gottschalk v. Benson*, 409 U.S. 63, where at page 65, the Supreme Court says: "A procedure for solving a given type of mathematical problem is known as an *algorithm*." The Court further qualifies the algorithm as one strictly relevant to digital computers, saying at page 71: "We have, however, made clear from the start that we deal with a program only for digital computers."
>
> Digital computers deal with numbers or number systems only. The Court's attention in *Benson* is equally confined to an algorithm that treats numbers or number systems. The algorithm is nowise extendible into the subject matter of physical geometry.

> Physical geometry is essential for the statement of a vector. Numbers alone can not do it. For this and other reasons, the holding in *Benson* does not possibly interfere with the patentability of the '052 invention. (PRDMSJ, pp. 43–44)

The adm. judge took pieces of this argument out of context and recast them to make false and defamatory attributions.

13(d). The Opinion of the adm. judge reports as follows on a point made by plaintiff in the hearing of Feb. 8, 1979:

> Plaintiff maintains, however, that claim 2 does not preempt a mathematical equation because the preamble "[a] directional computer" adequately limits the scope of the claim to a particular technology, *i.e.*, the directional computer technology. We find as a matter of law, however, that those words do not effectively limit the claim to any *particular* technology. (App. 3, 20a–21a; App. 4, 54a.)

The first sentence, which is attributed to plaintiff, is another malicious fabrication. The record of the case up to the filing of the adm. judge's Opinion shows only that the term "directional computer" is the title of the '052 patent; that it is an original terminology having no prior history of use or meaning; that it is the name plaintiff gave to the '052 invention. As said in par. 10(d), plaintiff spoke the name "directional computer" at the hearing to point out that it implies a source of directional information, that element (a) is that source, and that element (a) may not be denied. The matter is so understood from the claim itself (par. 10(a)). The adm. judge produced a parcel of degenerate lies in order to malign the plaintiff and distort the issues.

14(a). The Opinion of the adm. judge on the motions for summary judgment severely underrepresented and misrepresented the '052 invention and its underlying principles. The adm. judge purported to discuss the latter

in Appendix B of the Opinion, *using material of his own making.*

14(b). Appendix B does not provide a true discussion of vectors. A vector, as a real quantity, exists only in connection with a physically demonstrated direction or a set of such directions in a rigid body. This fact is pointedly omitted in Appendix B and is contradicted as well. The appendix carries such misleading statements as:

> [A] full description of the vector quantity would require a statement of its *direction* as well (*e.g.*, N.E.). (App. 3, 29a.)
>
> The specification of a vector quantity is always dependent on the frame of reference of its observer. (App. 3, 29a.)

14(c). The '052 patent says for itself what a vector is:

> In general, a vector consists in one or more scalar values assigned to one or more physically defined directions. (App. 6, col. 3, lines 14–16.)

The special case of a physically defined direction, per se, may be identified as a unit vector or as an axis. A set of three mutually perpendicular, physically defined directions constitutes a reference frame. Contrary definitions in respect of the '052 patent are unlawful.

14(d). Appendix B also purports to explain the vector cross product and vector integration. It merely trifles with these subjects and says nothing about the practice of integrating a vector relative to space in a rotating frame of reference, where this rotation is compensated or it may be applied to perform the integration ('052 claims 1 and 24). The appendix really means to frustrate this knowledge.

14(e). The text of the adm. judge's Opinion used only ten lines of the patent to describe the invention, from a specification nearly ten columns long not counting the claims. (App. 3, 7a; App. 4, 40a.) The lines were selected

from the introductory remarks of the patent with care *not* to include such matter as:

> [T]he directional computer can be realized in conjunction with any physically demonstrated frame of reference. (App. 6, col. 1, lines 19–21.)
>
> The directional computer proceeds on the principle that a direction changes when it is given an angular velocity. (App. 6, col. 1, lines 22–24.)
>
> The directional computer, *in all its embodiments*, is an implementation of the *relationship*:
>
> $$\mathbf{b} = \int (\cdots \mathbf{b} \times \mathbf{Y})\, dt \qquad (1)^{6/}$$
>
> where **b** represents the directional output vector; **Y** represents any given vector or the result of a combination of vectors . . . (Emphasis added.) (App. 6, col. 2, lines 1–8.)

The '052 patent develops and specifies these matters in detail. The adm. judge evaded these particulars except in the act of misrepresenting them (par. 18(a–d) below). The '052 patent also provides significant teaching and practical examples of the input vector **Y** for use in flight control. The adm. judge disregarded all of it except for one introductory sentence, as if there were no more than that.

15(a). The Opinion of the adm. judge introduced its analysis of the claims by saying:

> The issue to which we now direct our attention is whether, under the rationale of *Benson*, these claims "wholly pre-empt the mathematical formula" which they incorporate. (App. 3, 16a; App. 4, 50a.)

6/ This equation describes the rotational motion of a rigid body where **b** represents a vector fixed in the body and **Y** represents the angular velocity of the body. It has been known in this context for at least 150 years. In the '052 invention, **b** and **Y** are produced as freestanding quantities.

15(b). The rationale of *Benson* is based on the following declarations:

> The claims were not limited to any particular art or technology, to any particular apparatus or machinery, or to any particular end use. 409 US 63, 64.
>
> A digital computer, as distinguished from an analog computer, operates on data expressed in digits, solving a problem by doing arithmetic as a person would do it by head and hand. *Id.* at 65.
>
> We have, however, made clear from the start that we deal with a program only for digital computers. *Id.* at 71.

At most, *Benson* applies to a claim of ordinary arithmetic that is not otherwise limited.

16(a). The adm. judge began his analysis of the claims by producing an illegal, "summarized" version of claim 2, as follows:

> (a) a physically defined, stabilized reference frame[12]
>
> (b) means of obtaining input signals defining an input vector in relation to the stabilized reference frame; and
>
> (c) means to calculate $\mathbf{b} = \int (\mathbf{b} \times \mathbf{Y})\, dt$, where $\mathbf{Y}$ is the input vector, $\mathbf{b}$ is the output vector, and the integration is relative to the stabilized reference frame.[13] (App. 3, 17a; App. 4, 50a.)

35 USC § 112 requires that:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming *the subject matter which the applicant regards as his invention.* (Emphasis added.)

The law plainly reserves the statement of a claim to the inventor. It also sets the standard of "particularly pointing out and distinctly claiming the subject matter." The adm. judge violated the law on both counts.

16(b). The adm. judge's footnote 12 on element (a) reads as follows:

> [12] This element is further described in the claim as "having means of sensing and suppressing its angular velocity." However, it is clear from the specification that this language merely clarifies the essential nature of a "stabilized reference frame" and thus is without limiting effect. *See* col. 5, lines 4–9. To be sure, plaintiff wholly agrees with this conclusion. *See* PRDMSJ at ¶ 49. (App. 4, 50a; App. 3, 17a, n. 13.)

This statement is false. To be correct, it should have to say that: The physically defined, stabilized reference frame includes "means of sensing and suppressing its angular velocity" and implies these limitations. A person unskilled in the art would read the adm. judge's statement to mean that the "means of sensing and suppressing its angular velocity" are not significant as limitations. Indeed, one has to believe that it was the adm. judge's purpose to create that impression. Why else delete the language from element (a) and then trivialize it in a footnote. The last remark in the footnote:

> To be sure, plaintiff wholly agrees with this conclusion. *See* PRDMSJ at ¶ 49

is totally deceitful. The cited ¶ 49 discusses the amendment of claim 2 which entered the phrase "having means of sensing and suppressing its angular velocity." The Patent Office examiner wanted these means recited in the claim to *make their presence clear.* ¶ 49 makes exactly this point.

16(c). The adm. judge's footnote 13 on element (c) says:

> [13] This element is further described in the claim by the language "whereby the said output vector rotates around the said input vector." However, this language has no limiting effect for it is clear that in every implementation of the claimed equation the

> "output vector rotates around the said input vector" whether it rotates to trace a conical surface around the input vector or seeks coalignment with it. *See also* n. 43, *infra*. (App. 4, 50a; App. 3, 17a, n. 14.)

Contrary to the adm. judge's statement, the language "whereby the said output vector rotates around the said input vector" can not and does not belong to the true element (c) (recited in par. 10(a)). It makes the statement, *of the claim as a whole*, that the output vector is made to receive the input vector as its angular velocity. However, the question remains: why delete the language. The motivation is evident. The language describes *motion* as an action created. It doesn't fit the meaning of "calculation" or any other computation of the *Benson* kind.

16(d). As rewritten by the adm. judge, element (c) is constructed of vectors rather than numbers. It necessarily embraces mechanical structure in support of the vectors. The element is clearly deficient in "particularly pointing out and distinctly claiming" its subject matter.

17(a). The adm. judge continued his claim analysis as follows:

> The Supreme Court has indicated in *Benson* that a claim should be "limited to [a] particular art or technology, to [a] particular apparatus or machinery, [and] to [a] particular end use." 409 U.S. at 64, 175 USPQ at 674. If we consider only element (c) of claim 2 for the moment, it is clear that it violates each and every requirement of this rule. First, it in no way specifies any use for the calculated output vector and, therefore, is not "limited to any particular end use." Second, the "means plus function" language encompasses any and every type of apparatus or machine which could be used to implement the claimed equation and, therefore, the element is not "limited to any particular apparatus or machinery." Finally, the element has application in arts or technologies as diverse as the equation itself and,

therefore, is not "limited to any particular art or technology." The element truly does, in the *Benson* sense, wholly preempt the mathematical formula which it embodies.

Of course, claim 2 recites more than merely element (c). However, the effect of additional elements (a) and (b) in claim 2 is insufficient to factually or legally distinguish the claim from the type held to be unpatentable in *Benson*. The reason for this conclusion becomes clear upon an understanding of the purpose of these elements.

As we have stated above, element (c) merely calls for means to perform a mathematical computation which, by itself, is unpatentable subject matter. Because the equation recited in element (c) is a calculation using an input vector, *i.e.*, **Y**, apparatus performing that calculation necessarily requires means to generate the value of the input vector, **Y**. Element (b) is for just that purpose and, therefore, is essential to the performance of the computation. Thus, the "limitation" in the claim effectuated by the addition of element (b) is, for all practical purposes, not a limitation at all because element (c) cannot function in the absence of element (b). Of course, if element (b) recited apparatus which generated a *particular* type of input signal, such as a specified physical quantity, our conclusion might be different. But it does not, and, in fact, it states that the input signals defining the input vector may be representative of "any desired value."

The same is true of element (a). Because the equation claimed in element (c) operates exclusively on vectors, as we have pointed out in our background mathematics discussion, Appendix B, *infra*, all vectors *must* be expressed in terms of a frame of reference and, therefore, a reference frame is also essential to the implementation of the claimed equation.[14] This is the purpose of element (a) and it

> too, therefore, is essential to the performance of the computation claimed in element (c). While it is true that element (a) is limited to a particular type of reference frame, *i.e.*, a "physically defined, stabilized reference frame," the very nature of the claimed equation requires this specific type of reference frame to produce a meaningful result.[15] (App. 3, 17a–19a; App. 4, 51a–52a.)

17(b). This claim analysis is devious and fraudulent throughout. It begins with a brazen misrepresentation of the Supreme Court. In 409 US 63, 64, the Supreme Court remarks on the *Benson* claims to note that:

> The claims were not limited to any particular art or technology, to any particular apparatus or machinery, or to any particular end use.

Any one of these limitations may qualify a claim as patentable subject matter. The adm. judge's assertion that the limitations need to be collectively satisfied by a claim is totally false. As its basic theme, the "claim analysis" uses and misuses an improper version of the claim and argues contradictions, absurdities, and double-talk. The following instance is notable:

> [T]he effect of additional elements (a) and (b) in claim 2 is insufficient to factually or legally distinguish the claim from the type held to be unpatentable in *Benson*.

Element (a) is apparatus comprising gyroscopes, gimbals, and control motors. The type of claim held to be unpatentable in *Benson* is a program for digital computers. To say that these things are factually or legally indistinguishable from each other is absurdity in the extreme. The assertion also harbors double-talk. In the adm. judge's version of the claim, elements (a) and (b) are already constituents of element (c); they are not "additional." The adm. judge decries element (c) as *Benson* arithmetic through most of his "claim analysis"; at

the end he gives element (c) its due as a possessor of mechanical structure:

> Because the equation claimed in element (c) operates exclusively on vectors, . . . all vectors *must* be expressed in terms of a frame of reference and, therefore, a reference frame is also essential to the implementation of the claimed equation. This is the purpose of element (a) and it too, therefore, is essential to the performance of the computation claimed in element (c).

This statement clearly concedes that the claim as a whole, whatever the version, is limited to machinery. And the reference to *Benson* is baseless (cf. par. 15(b) and 20(a–c)). If the adm. judge had preserved the claim's true language, he might also have remembered that element (b) is indeed:

> a *particular* type of input signal, such as a specified physical quantity. (cit., par. 17(a))

It is a vector of *angular velocity*, which he well appreciated in his fn. 13 (cit., par. 16(c); see also par. 22, 23).

18(a). The '052 patent demonstrates in itself that none of its claims wholly preempts an equation or a mathematical formula. The adm. judge deliberately lied to conceal this fact.

18(b). The adm. judge's claim analysis carries footnote 15 which reads as follows:

> [15] The claimed equation, $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y}\, dt$, is but one embodiment of the more general equation $\mathbf{b} = \int ((A/b^2 - B)\mathbf{b} + \mathbf{b} \times \mathbf{Y} + \mathbf{b} \times \omega)\, dt$, (*see* col. 4, equation (17)) with $A/b^2 - B = \omega = 0$ by definition. To make $\omega = 0$, however, *requires* a "physically defined, stabilized reference frame." *See* col. 5, lines 1–7. Thus, the claimed equation cannot be meaningfully implemented with any other type of reference frame. *Accord, see* plaintiff's submission to standard pretrial

order on liability (PSPOL), ¶¶ 23, 24 (filed February 27, 1978). (App. 4, 52a; App. 3, 19a, n. 16.)

This footnote has three inexcusable misstatements. Explaining the first of them explains the others. The matter is treated in the '052 patent between col. 4, line 59 and col. 5, line 9, as follows:

> The directional computer can be realized in conjunction with a reference frame formed by a physically defined set of three mutually orthogonal directions, providing the component angular velocities (relative to space) of this reference frame are known by measurement or otherwise. Relation (1) is stated for such a reference frame F as
>
> $$\mathbf{b} = \int_F ((A/b^2 - B)\mathbf{b} + \mathbf{b} \times \mathbf{Y} + \mathbf{b} \times \omega)\, dt, \qquad (17)$$
>
> where the subscript F on the integral sign identifies F as the reference frame for the integration (the reference frame relative to which the integration proceeds) and ω represents the angular velocity of F. The process of integrating relative to a reference frame F means only that the components of the integrand as observed in F are the quantities to be integrated. The resulting integral outputs have the same reference axes as their respective integrands and express the integral output vector. When the reference frame F is held fixed in space by maintaining its angular velocity ω at zero, relation (17) obtains its functionally equivalent form of relation (1). The integral sign, without subscript, in relation (1) is understood to represent integration relative to space. (App. 6, col. 4, line 59 – col. 5, line 9.)

It is noticed that fn. 15 of the adm. judge omits the subscript F on the integral sign of equation (17). This subscript signifies that the integration proceeds in relation to a frame F which may rotate in any manner whatever. The vector ω quantifies the rotation of F in

space. The '052 sentence introducing equation (17) says that relation (1) is equally produced by equation (17), as $\mathbf{b} = \int((A/b^2 - B)\mathbf{b} + \mathbf{b}\times\mathbf{Y})\,dt = \int_F((A/b^2 - B)\mathbf{b} + \mathbf{b}\times\mathbf{Y} + \mathbf{b}\times\omega)\,dt$.[7/] It concurs with the statement at the top of col. 2 that "[t]he directional computer in all its embodiments is an implementation of the relationship: [eq. (1)]." (cit., par. 14(e)). This concurrence is again noted in the last two sentences of the '052 statement, where the two integrations are said to be "functionally equivalent."

18(c). Plaintiff's response to defendant's motion for summary judgment discusses the matter anew in ¶ 19, pp. 9–10, which reads as follows:

> 19. In pages 17 and 18 of his Motion for Summary Judgment Under Rule 101, filed Mar. 30, 1978, the defendant relies on Shames (DX-8) to explain how the integral of a vector is evaluated. In effect, Shames says: Integrate the three rectangular components of the vector individually. This is plainly a deficient answer from the standpoint of providing a useful result. Shames gives no care at all to the state of the reference frame, as to whether it is rotating or nonrotating. The usefulness of a vector integration (its compatibility with Newton's Laws of Mechanics) depends on properly accounting for the rotational state of the reference frame. The '052 patent carefully attends to this requirement in the passage that is above quoted in par. 12 [same as '052 cit. in preceding par. 18(b)]. Accordingly, in a space stabilized reference frame, the '052 integration proceeds as
>
> $$\mathbf{b} = \int \mathbf{b}\times\mathbf{Y}\,dt = 1\int(b_2Y_3 - b_3Y_2)\,dt + 2\int(b_3Y_1 - b_1Y_3)\,dt + 3\int(b_1Y_2 - b_2Y_1)\,dt.$$
>
> In a rotating reference frame identified as F = **1**, **2**, **3** and having the angular velocity ω relative to space

---

[7/] The claims do not involve the quantity $(A/b^2 - B)\mathbf{b}$.

(as measured by gyroscopes) the same integration proceeds as

$$\mathbf{b} = \int_F (\mathbf{b}\times\mathbf{Y} + \mathbf{b}\times\omega)\,dt = \mathbf{1}\int((Y_3+\omega_3)b_2 - (Y_2+\omega_2)b_3)\,dt$$
$$+\mathbf{2}\int((Y_1+\omega_1)b_3 - (Y_3+\omega_3)b_1)\,dt$$
$$+\mathbf{3}\int((Y_2+\omega_2)b_1 - (Y_1+\omega_1)b_2)\,dt.$$

It is only by these practices that the output **b** is useful and is produced as an identical result by either integration, as

$$\mathbf{b} = \int \mathbf{b}\times\mathbf{Y}\,dt = \int_F (\mathbf{b}\times\mathbf{Y} + \mathbf{b}\times\omega)\,dt.$$

¶ 47 of PRDMSJ cites a similar statement from the file wrapper of the '052 patent application (see par. 27(c)).

18(d). In footnote 15 of the Opinion, the adm. judge asserts that the claimed equation cannot be meaningfully implemented with any other type of reference frame than a physically defined, stabilized reference frame. This assertion is blatantly false. The adm. judge then compounds the falsehood by falsely representing *"accord"* from ¶s 23, 24 of plaintiff's submission to the standard pretrial order on liability. ¶ 24 simply defines a space fixed reference frame, i.e., element (a). ¶ 23 reads as follows:

> 23. The need for a space stabilized reference frame or the equivalent information in the form of a physically defined reference frame whose angular velocity relative to space is known arises in connection with the computation of a vector integration or a vector rate of change. Such vector computations are necessarily performed relative to space if they are to be consistent with Newton's laws of motion.

This paragraph clearly says that integration relative to space may be performed in a rotating reference frame whose angular velocity relative to space is known. The '052 citation, par. 18(b), begins on this very point in unmistakable language. The '052 patent specifies an embodiment of relation (1) in a rotating frame of reference

(App. 6, col. 5, lines 28–70) and claims it by claim 1. Claims 1 and 2 are functionally equivalent embodiments, and neither one preempts the other. Claim 24 is another mechanically and arithmetically distinct embodiment of relation (1). It performs the vector integration entirely by means of rotating the reference frame (App. 6, col. 7, lines 4–72). The adm. judge perjured himself to deny a large array of evidence that obliged him to find claim 2 valid under his *own* false use of *Benson* (cf. par. 15(a,b)).

19. The adm. judge also alleged preemption in defiance of the prior art in evidence. This evidence proceeded from references to prior patents of Slater and Arshal by the Patent Office. It was cited from the '052 file wrapper in ¶ 46 of PRDMSJ as follows:

> Both of the patents perform the operation:
>
> $$\mathbf{V} = \int_F (\mathbf{A} - \omega \times \mathbf{V})\, dt,$$
>
> where ω represents the angular velocity of a physically defined reference frame F and the vectors **A**, **V**, and $\omega \times \mathbf{V}$ all refer to F. This last fact is denoted by the subscript F on the integral sign. . . .
>
> The above relationship of Slater and Arshal places the input vector **A** under direct integration, since the integral is divisible into two parts as:
>
> $$\mathbf{V} = \int_F \mathbf{A}\, dt - \int_F \omega \times \mathbf{V} dt.$$
>
> My present invention has no such operation as the direct integration of an input vector. In every case, the input vector is itself modified by the output vector before being integrated into the output. . . .
>
> The cited patents of Slater and Arshal show no interest whatsoever in redirecting an output vector at will. They are basically intent on obtaining just the mathematical integral of an input vector **A** relative to space, with this computation being performed in relation to a rotating frame of reference. Stated otherwise, Slater and Arshal obtain the integral:
>
> $$\mathbf{V} = \int_S \mathbf{A}\, dt = \int_F (\mathbf{A} - \omega \times \mathbf{V})\, dt$$

> by the second form of these two mathematically equivalent integrals of which the first refers to a space fixed frame of reference. . . . (PRDMSJ, ¶ 46)

This prior art utilizes the same scientific principle or equation as the '052 invention. The integration $\int_F -\omega \times \mathbf{V} dt$ rotates the output vector **V** relative to F to counterbalance the rotation of F in space. Consequently, the input integration, $\int_F \mathbf{A} dt$, is maintained in F as an integration relative to space. Since a patent claim is necessarily distinguished from the prior art, or else it is disqualified by the prior art, it can not preempt a scientific principle or equation that is already in the prior art.

20(a). One apparent reason why the adm. judge altered claim 2 was to make it readable backward. He could not otherwise attempt to diminish element (a) of claim 2.

20(b). The adm. judge contradicted unbiased, expert testimony when he subordinated the status of element (a). In finding infringement, the adm. judge took direct notice of element (a) from PX-22 (NAVORD OP 3557, *Guidance System Poseidon, Mark 3*, Change 2, Rev. 1, p. 3-3) as follows:

> 3.2.1 (U) INERTIAL REFERENCE SUBSYSTEM. The basic function of the inertial reference subsystem, figure 3-4, is to provide a *stable platform* for the acceleration measurement subsystem and to provide a reference platform for missile attitude control. As shown in figure 3-4, the inertial reference subsystem comprises three gyros, three gyro output amplifiers (in one module), a gyro error resolver, three gimbal servo modules, five torque motors, three tachometers, and three gimbals. *The three gyros on the gimbal-mounted stable platform provide error signals indicating angular displacements of the platform with respect to inertial space.* The error signals are amplified by the gyro output amplifier and

> the gimbal servo modules and *the amplifier outputs are used to drive the gimbal torque motors to null the platform angular displacement.* (App. 4, 73a–74a.)

The emphasis in this quotation was inserted by the adm. judge. It particularly notes the three constituents of element (a), which are: 1. the physically defined reference frame; 2. the means of sensing the angular motion of the reference frame; and 3. the means of suppressing the angular motion of the reference frame. In view of the purpose of the '052 invention, the following emphasis is more appropriate to the first sentence:

> *The basic function* of the inertial reference subsystem, figure 3-4, is to provide a *stable platform* for the acceleration measurement subsystem and to provide a *reference platform for missile attitude control.*

Plaintiff's motion for summary judgment also cited like testimony from PX-27 (LMSD-450765, *Preliminary Flight Dynamics – Polaris A1 (Mark 1 Mod 0) Missile*, Lockheed Missiles and Space Division, 15 April 1960, p. 3-37) as follows:

> The inertially stable platform is the heart of the guidance system. An array of inertial-reference integrating-gyros (IRIG) and associated servos keep the inner gimbal of the guidance platform directionally fixed in inertial space. (PMSJ, App. C, p. 2; also in PRDMSJ, ¶ 6(g), p. 6)

These citations leave no doubt of the fundamental importance of element (a). They also make it plain that element (a) is patentable subject matter for itself. The adm. judge took due notice of this himself when he cited ¶ 42 of PRDRA (par. 28 below) which says:

> [element (a)] is disclosed in U.S. patent No. 2,752,793 to Draper et al.

The Draper patent (PX-6) claims element (a) as such. It is but one of a number of such patents.

20(c). With element (a) in its proper place at the head of claim 2, elements (b) and (c) [par. 10(a)] build on it to bring additional limitations to the claim. The combination represents patentable subject matter no less than element (a) alone. The adm. judge altered the claim and read it backward with the singular purpose to distort and defeat the claim.

21(a). The adm. judge willfully ignored the fact that the basic equation used in the '052 invention was known as an equation of rigid-body motion long before the '052 patent.

21(b). The '052 patent takes this fact for granted:

> The directional computer proceeds on the principle that a direction changes when it is given an angular velocity. (App. 6, col. 1, lines 22–24)

The equation goes beyond these words just to describe the exact geometry by which the direction responds to the angular velocity. Plaintiff's response to defendant's motion for summary judgment, pp. 44–45, expressly cites the equation from PX-28 (Milne, E.A., *Vectorial Mechanics*, Interscience, New York, 1948, pp. 162–164) where it is derived as a consequence of rigidity, i.e., for any rigid system of particles. The defendant acknowledged plaintiff's citation from PX-28 and some statements that came with it as follows (defendant's reply, p. 24):

(1) "The equation [$\mathbf{b} = \int \mathbf{b} \times \mathbf{Y} dt$] expresses the principle that a direction changes when it is given an angular velocity, where **b** represents the direction and **Y** represents the angular velocity", and the principle is old. (p. 44.) The defendant agrees.

(2) That one use of the equation is the simple act of turning a rigid body (p. 44). The defendant agrees.

(3) That the relationship

$$\frac{d\mathbf{r}}{dt} = \Omega \times \mathbf{r},$$

where **r** represents a vector fixed in a rigid body

and Ω represents the angular velocity of the rigid body, is taught by *Milne*, PX-28 (prior art) (p. 45). Furthermore, this relationship is functionally the same as:

$$\mathbf{r} = \int \Omega \times \mathbf{r}\, dt \quad \text{(p. 45)}.$$

The defendant agrees.

21(c). The scope of this equation is immense. The only way one can wholly preempt the use of this equation is to claim every rigid body in the universe.

21(d). PRDMSJ, p. 45, further speaks of this equation as follows:

> It is also used in the guidance system of some air-to-air missiles. The missile is equipped with a radar or infrared seeker head which tracks a target and mechanically establishes the line of sight of the target from the missile. The missile is maneuvered so that the line-of-sight rate, as measured by gyroscopes, is brought to zero. When the line of sight is nonrotating, the missile's position and velocity relative to the target are coaligned and the latter directly closes out the former.

This statement represents evidence of nonpreemption that is readily produced as textbook matter. The defendant replied to it in continuation of the statements cited in par. 21(b), as follows:

> (4) The differential form of (3) has been used in certain missile guidance systems. (p. 45.) The defendant's counsel does not have this information.

The defendant's counsel apparently researched this matter and thought well of it. At any rate, defendant later proposed to produce such evidence, as stated below in par. 30(b).

22. The '052 patent discloses several input vectors that support various guidance functions. It anticipates the basic types used in Poseidon and Trident. It further

teaches their adaptation to particular functions through logical step by step development. A group of such examples, for use in aircraft, is designed around a vertical vector (as furnished by navigational instruments) and serves to establish independent, comprehensive, and simultaneous control over an aircraft's horizontal and vertical directions of flight. (App. 6, col. 2, line 44 – col. 4, line 50.) These input vectors are representative of element (b). The adm. judge gave them no recognition whatever (cf. par. 25(b)).

23. The adm. judge followed up his claim analysis with the allegation that elements (a) and (b) constituted "data gathering" steps and cited *In re Christenson*, 478 F.2d 1392, 178 USPQ 35 (CCPA 1973), as a "similar" case. (App. 3, 19a–20a; App. 4, 52a–53a.) *In re Sarkar*, 588 F.2d 1330, 200 USPQ 132 (CCPA 1978), and *In re Richmann*, 563 F.2d 1026, 195 USPQ 340 (CCPA 1977), were also cited. (App. 3, 20a; App. 4, 53a.) In all of these cases, the data gathering consisted of field measurements that were brought to a mathematical model or formula as *numbers* that conditioned a calculation. How element (a) can be said to fit this role is incomprehensible; it is incapable of providing a number. Element (b) is also unlike a simple number. Its numbers are assigned to the axes of element (a) and form a directed quantity. As so produced, element (b) expresses a vector obtained by the practices represented in par. 22. It acts in real time to redirect an output direction that is already *known*. The output direction is no more "calculated" than the axis of the Poseidon or Trident missile that follows it. The allegations of "data gathering" were flagrant misrepresentation.

24. The adm. judge concluded his prosecution of claim 2 as follows:

> As is apparent from a reading of claim 2 of the patent in suit, however, the sole purpose of the invention recited therein is merely to "compute a new value." Thus, for this reason and all of the reasons discussed

> above, we conclude that, under the rationale of *Benson* and its progeny, . . . claim 2 is invalid. (App. 3, 23a; App. 4, 56a.)

This statement is contemptible. A claim must express *subject matter*, not purpose, but the adm. judge did indeed know the purpose of claim 2. He knew the facts of infringement. He knew the invention's flight control function. And he knew that the '052 invention brought extraordinary structural, performance, and cost improvements to the Poseidon and Trident ballistic missiles. (See par. 4(a–e).) The agreed facts of record in corroboration were all before him in plaintiff's motion for summary judgment. Moreover, these subjects were thoroughly expounded on the first day of the hearing of Feb. 7–8, 1979, together with illustrations specific to the Polaris (prior art) and Poseidon missiles. The adm. judge simply had no use for the evidence. His mission was to destroy claim 2.

25(a). The adm. judge extended his treatment of claim 2 to claims 6, 3, and 7, the other claims in suit, and said:

> In summary, we have concluded that all of the claims in suit are invalid under the rationale of *Benson* and its progeny, because they preempt the mathematical formulae which they embody and, in practical effect, claim the mathematical formula itself. This conclusion, we think, is fortified by plaintiff's own admission that his invention is disclosed in a certain report, but that this report does not disclose *any* hardware or structure, *only mathematical equations*. *See* PRDRA at ¶ 17. (App. 3, 26a; App. 4, 59a.)

This statement adds false reason to a false conclusion. ¶ 17 of DRA, which plaintiff admitted, reads as follows:

> 17. The plaintiff maintains that Appendix B, Quarterly Report No. 2 (See Definitions, QR#2), discloses the directional computer without disclosing hardware or structure. (PRPOL, p. 26, No. 42) The hardware

> or structural means of implementing the concepts of Appendix B, Quarterly Report No. 2, are sufficiently taught in plaintiff's patent 2,923,465, issued February 2, 1960.

Quarterly Report No. 2, which predates the '052 patent application, discloses the *concept* of the directional computer. That is all it was intended to do. This mere disclosure does not give evidence of preempting anything. Furthermore, the mathematics defining the concept disclosed in Quarterly Report No. 2, Appendix B, is *vectorial* mathematics. It inherently represents structure. ¶ 17 of DRA plainly says that the concept requires "hardware or structural means" of implementation. The adm. judge willfully misused an innocent admission.

25(b). The adm. judge had no business even to consider Quarterly Report No. 2. His duty, which he actively violated, was to "construe" the claims "in the light of the specifications" of the '052 patent. *United States v Adams*, 383 US 39, 48–49 (1966); 35 USC § 112, 3rd par.:

> An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

26. In further creative testimony, the adm. judge attacked the '052 invention as the invention of a *new* equation. This act was clearly intended to evade the prior art (par. 19) and buttress the lie that the claims wholly preempted an equation. It came in connection with the defendant's motions for invalidity under 35 USC § 103 which sets requirements of non-obviousness from the prior art. The adm. judge responded to these motions as follows:

> While defendant has enumerated many grounds for this defense in its response to this court's standard

> pretrial order on liability (filed May 27, 1977), it has chosen to rely upon only two of these grounds in its motion for summary judgment. (App. 4, 59a–60a.)

To the first of the defendant's two grounds for invalidity under § 103, the adm. judge said:

> [T]he prosecution history clearly demonstrates that the claimed *equation*, not the special type of reference frame, was the material "distinguishing feature" of the claims,[26] and defendant has not even alleged, much less demonstrated, that the claimed *equation* existed in the prior art. (App. 4, 61a–62a.)

To the second ground for invalidity under § 103, the adm. judge said:

> Defendant's second ground is that the claims are invalid for obviousness because they call for hardware which would have been obvious from a knowledge of the claimed equation. While this may be true,[27] as we have pointed out heretofore, defendant has not even asserted, let alone established, that the claimed equation was known in the art. (App. 4, 62a.)

These statements are outright lies. The defendant's other defenses of obviousness are numbered 5, 6, and 7 in defendant's response to the standard pretrial order on liability. Defenses 5 and 6 begin with the assertion that the equation implemented in the '052 patent was "well-known" before the '052 filing date. The defendant makes this point repeatedly in further commentary. In taking notice of the defendant's many obviousness defenses, the adm. judge would surely have noticed the age of the equation. But if not, he was definitely obliged to notice it in plaintiff's response to defendant's motion for summary judgment and in defendant's reply thereto as noted above in par. 21(b).

27(a). The adm. judge produced fn. 26 (App. 4, 61a–62a.) to support his allegation that:

> [T]he prosecution history clearly demonstrates that the claimed *equation,* not the special type of reference frame, was the material "distinguishing feature" of the claims. (2nd cit., par. 26)

The footnote deserves scrutiny on this and other points. It reads as follows:

> [26] Prior to allowance, the claims were rejected on prior art which disclosed the equation
>
> $$\mathbf{V} = \int_F \mathbf{A}\,dt - \int_F \omega \times \mathbf{V}\,dt,$$
>
> where ω represented the angular velocity of a physically defined reference frame F, and **A** and **V** were other vectors referenced to F (note that the claimed equation is $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y}\,dt$). The examiner stated that the prior art teaches "the integral of the cross product of two vector quantities" and that it "is not of patentable significance what variable the applicant claims his vectors represent." In response, the applicant contended that it was not proper to equate the prior art angular velocity vector, ω, with the input vector, **Y**, because the angular velocity vector, ω, of his reference frame was always of zero value. Thus, the applicant contended, it was "impossible to derive from the 'teaching of [the prior art]' a device that is equivalent to mine." Although the examiner apparently was persuaded by this argument, he did not see how the claims limited the rotational velocity vector, ω, to a zero value and, accordingly, saw no difference between the equation *claimed* and the equation in the *prior art.* Although the applicant felt the limitation on ω was already implicit in his claims, he added the language "having means of sensing and suppressing its angular velocity" *to the reference frame* so as to explicitly force ω to a zero value. Thus, the addition of this crucial language was not to distinguish the claimed reference frame from the prior art, but to distinguish the claimed *equation* from the prior art. (App. 4, n. 26, 61a–62a.)

27(b). The prior art equation said in fn. 26 is delimited to its relevant part as

$$\mathbf{V} = -\int_F \omega \times \mathbf{V}\,dt = \int_F \mathbf{V} \times \omega\,dt.$$

The adm. judge noted a distinction between this equation and the equation $\mathbf{b} = \int \mathbf{b} \times \mathbf{Y}\,dt$. He noted correctly, including the fact that the variable represented by a vector is certainly of "patentable significance" when means of measuring the variable is called for. The distinction between the two equations resides in their informational content (cf. par. 27(c)) and in the character of their integrations which are said with and without a subscript on the integral signs. In the '052 patent, an integral sign without a subscript represents an integration relative to space (App. 6, col. 5, lines 7–9). The subscript F denotes generally any reference frame for the integration and ω represents the angular velocity of F relative to space (App. 6, col. 4, lines 59–73). The adm. judge clearly appreciated the difference between the integrations. He additionally demonstrated his appreciation of it in fn. 15 of his Opinion. There, he stripped away the subscript F from eq. (17) of the '052 patent, which erased the equality

$$\mathbf{b} = \int \mathbf{b} \times \mathbf{Y}\,dt = \int_F (\mathbf{b} \times \mathbf{Y} + \mathbf{b} \times \omega)\,dt.$$

He then contrived the conclusion that "$\omega = 0$ by definition" and that a "physically defined, stabilized reference frame" was required (see par. 18(b)). It was a calculated, criminal act.

27(c). Fn. 26 gives a meager, falsified account of the '052 patent's prosecution history. PRDMSJ presented a thorough, verbatim account of plaintiff's transactions with the Patent Office in ¶s 44–49, pp. 24–30. Portions of the verbatim account in ¶ 47, which responded to the examiner's second office action, follow:

> I would begin my arguments from the context of claim 1 which has been found allowable and which is summarized by the relationship:

$$\mathbf{b} = \int_F (\mathbf{b} \times \mathbf{Y} + \mathbf{b} \times \omega) dt. \qquad (1)$$

This integral relationship is equivalently produced as

$$\mathbf{b} = \int_S \mathbf{b} \times \mathbf{Y} dt, \qquad (2)$$

where, in this case, the subscript S denotes a stabilized reference frame and the cross product $\mathbf{b} \times \mathbf{Y}$ is referred to S for its integration. It is clear, by inspection, that relation (1) evolves directly into relation (2) when ω (the angular velocity of reference frame F) is maintained at zero. In that circumstance, F has become a stabilized reference frame. But this does not just happen. *The reference frame is so stabilized by means of sensing and suppressing its angular velocity.* . . . .

. . The Slater patent that has been cited against [the claims] revolves entirely around the construction:

$$\mathbf{V} = \int_F (\mathbf{A} + \mathbf{V} \times \omega) dt, \qquad (3)$$

. . Clearly, the Slater construction [relation (3)] is possibly cited against my constructions of relation (2) only in a portion of it consisting as:

$$\mathbf{V} = \int_F \mathbf{V} \times \omega \, dt. \qquad (4)$$

. this relation (4) from Slater carries just two elements of information, namely: an output vector **V** and a vector ω expressing the angular velocity of the reference frame F. In comparison, my relation (2) carries three elements of information. They are: an output vector **b**, an input vector **Y**, and an angular velocity vector $\omega = 0$. The fact that the angular velocity is held at zero in the act of stabilizing the reference frame does not diminish the fact of expressing the value of the angular velocity. . . . .

. . In itself, relation (4) from Slater succeeds only in establishing an output vector that is fixed in space . . . . Relation (2) accomplishes the same thing when its integrand is altogether eliminated (that is: $\mathbf{b} \times \mathbf{Y} = \mathbf{Y} = 0$). Therefore, the presence of this inte-

> grand, which drives the output vector, is a presence that is completely absent in the case of Slater. . . . (PRDMSJ, ¶ 47)

Nowhere in these or any other arguments presented to the examiner did plaintiff say that:

> it was not proper to equate the prior art angular velocity vector, ω, with the input vector, **Y**, *because the angular velocity vector, ω, of [plaintiff's] reference frame was always of zero value.* (Fn. 26, par. 27(a); emphasis added.)

The adm. judge was an unrelenting liar.

27(d). The language "having means of sensing and suppressing its angular velocity" points out particular subject matter belonging to the stabilized reference frame. It accords with well-known prior art. To suggest that "this crucial language was [added] . . . to distinguish the claimed *equation* from the prior art" (fn. 26) was malicious nonsense. The adm. judge spoke of it as anything but "crucial language" when he removed it from claim 2 (cf. par. 16(a,b)).

28. In fn. 27 of his Opinion, the adm. judge further promoted the falsehood that the equation was new by conjuring up misstatement and false innuendo, as follows:

> [27] Plaintiff has already admitted that all of the claimed elements, except the equation, were old. *See* PRDRA at ¶¶ 16(b), 22, 28, and 42. (App. 4, 62a.)

The ¶s of PRDRA cited in fn. 27 say nothing about any equation being old or new. Nor do they admit that all the elements of the claims are old. On the contrary, the '052 input vectors were entirely new in concept, function, teaching, and examples. The concept of using a steerable vector to direct flight was new in itself. The record is absolutely clear and steadfast on these issues. The '052 invention adapted an old equation, or its principle, to the practice of these concepts and was *a unique combination of elements, as claimed.*

29(a). Plaintiff requested review of the adm. judge's Opinion by the Court of Claims and performed the arduous task of excepting to a great many factual and legal misstatements while also having to bring to light many points of fact and law that had been ignored. This effort went for naught. Plaintiff's briefs were not read.

29(b). Plaintiff appeared for oral argument before the review panel of the Court of Claims on Jan. 8, 1980. Plaintiff assumed that the judges would have read the adm. judge's Opinion and the briefs filed by both parties pursuant to the review and began the argument accordingly. Plaintiff made an early reference to "element (a)" and was there interrupted by one of the judges. The judge demonstrated complete ignorance of element (a), including ignorance of its existence, not merely of its substance. He then berated plaintiff for not being represented by an attorney, after which he admonished plaintiff to explain the invention from the beginning.

29(c). The presiding judge was the only member of the review panel who indicated any acquaintance with the material in the case. He appeared to have read the Opinion of the adm. judge, but nothing more.

29(d). The presiding judge was generally unreceptive to anything plaintiff had to say. He declared his incompetence at patent law and his bias with such statements as:

> Don't try to tell me what a vector is. I learned vectors in high school. I know what a vector is.
>
> You can't get a patent on such broad claims.

When plaintiff subsequently described the improvements achieved in the Poseidon and Trident missiles by the use of the '052 invention, the presiding judge responded with a gesture of scorn by face and hand.

29(e). The final insult came during the argument of defendant. The presiding judge asked the counsel for the defendant: Did he (the counsel) think the adm. judge was right? The counsel quickly answered yes. The presiding

judge then asked: Would the court's decision have to include any discussion of infringement or obviousness if it found for invalidity? The counsel answered no. The decision of the Court of Claims was thus pronounced. *Arshal v United States*, 621 F.2d 421, 423 (1980). An Opinion founded on lies, fraud, and contempt of law was blatantly ratified without even the pretense of a review.

30(a). The court's Decision was formally issued on March 19, 1980, after which plaintiff obtained representation by an attorney. Plaintiff's attorney filed two motions. The first was for a stay of all proceedings pending the review by the Supreme Court of the cases of *Diehr* and *Bradley*. These cases proceeded from the Court of Customs and Patent Appeals. The Patent Office had denied the *Diehr* application as a claim to a calculation limited by "post-solution activity" as in *Parker v Flook*, 437 US 584, 590. The CCPA reversed the Patent Office, declaring that:

> If the claim is drawn to subject matter, *which is otherwise statutory*, it does not become nonstatutory merely because a computer is involved in its execution. (Emphasis supplied.) 602 F.2d 982, 985 (Aug. 9, 1979).

This issue and the same rationale applied no less to plaintiff's claims. Moreover, plaintiff's claims presented no question of "post-solution activity" and stood patented by the Patent Office. The second motion of plaintiff by his attorney asked the Court of Claims for a rehearing and suggested a hearing en banc in view of the large monetary consideration that was involved and the widespread errors of fact and law tainting the Court's Decision. The Court denied both motions (June 27, 1980).

30(b). These motions for a stay and a rehearing argued from the line of cases decided by the CCPA after *Benson* and from the facts that are said herein in par. 4(a–e), 10(a), 15(a,b), 16(c,d), 17(b), 18(a–d), 19, 20(b,c), 21(a–d), 22, and 23. The Court necessarily learned that:

1. Its Decision expanded the range of *Benson* to embrace machinery and was unprecedented. 2. Its criterion of preemption (par. 15(a) and 25(a)) was falsely applied. Even the defendant argued the latter point. In its Opposition to the motion for a stay, the defendant declared that:

> The equation is not new and if this case has to go to trial the defendant is prepared to show by expert testimony that not only is the equation not new but that *a form of the same equation* was used in prior art missiles. (p. 15) (Emphasis added; see par. 21(d).)

The Court was simply not interested in the facts and the law. It was clearly in league with its adm. judge and was intent on preserving his work.

31. Plaintiff next petitioned the Supreme Court for certiorari to the Court of Claims on the question of "[w]hether a claim to flight control apparatus becomes unpatentable under 35 USC § 101 because it involves numerical computation" (Case No. 80–437, filed Sept. 19, 1980). However, the Supreme Court already had the case it wanted in *Diamond v Diehr* and plaintiff's appeal was severely handicapped for having to proceed on a record befouled by official lies and fraud. In the brief in opposition, the defense counsel and higher officials of the Department of Justice cited this false matter unsparingly. Plaintiff's petition was denied.

32. In *Diamond v Diehr*, 450 US 175 (March 1981), the Supreme Court recognized the patent law with respect to statutory subject matter and the treatment of claims as follows:

> . . Congress intended statutory subject matter to "include anything under the sun that is made by man." (p. 182)
>
> [A] claim drawn to subject matter otherwise statutory does not become nonstatutory simply because it uses a mathematical formula, computer program, or digital computer. (p.187)

". . The term machine includes every mechanical device or combination of mechanical powers and devices to perform some function and produce a certain effect or result. . . . [One] would have a patent for the means or method of producing a certain result or effect, and not for the result or effect produced. It is for the discovery or invention of some practical method or means of producing a beneficial result or effect that a patent is granted and not for the result or effect itself." (n. 7, pp. 182–183, recited from *Corning v Burden*, 15 How 252, 267–268, 14 L Ed 683 (1854))

It is now commonplace that an application of a law of nature or mathematical formula to a known structure or process may well be deserving of patent protection. (p. 187)

In determining the eligibility of respondents' claimed process for patent protection under § 101, their claims must be considered as a whole. It is inappropriate to dissect the claims into old and new elements and then to ignore the presence of the old elements in the analysis. . . . . The "novelty" of any element or steps in a process, or even of the process itself, is of no relevance in determining whether the subject matter of a claim falls within the § 101 categories of possibly patentable subject matter. (pp. 188–189)

We recognize, of course, that when a claim recites a mathematical formula (or scientific principle or phenomenon of nature), an inquiry must be made into whether the claim is seeking patent protection for that formula in the abstract. A mathematical formula as such is not accorded the protection of our patent laws, *Gottschalk v Benson*, 409 US 63, 34 L Ed 2d 273, 93 S Ct 253 (1972), and this principle cannot be circumvented by attempting to limit the use of the formula to a particular technological environment. *Parker v Flook*, 437 US 584, 57 L Ed 2d 451, 98 S Ct

> 2522 (1978). . . . . On the other hand, when a claim containing a mathematical formula implements or applies that formula in a structure or process which, when considered as a whole, is performing a function which the patent laws were designed to protect (e.g., transforming or reducing an article to a different state or thing), then the claim satisfies the requirements of § 101. (pp. 191–192)

The force of this last statement is unmistakable. The Supreme Court says, with finality, that when a claim implements or applies a mathematical formula or scientific principle in a structure or process and performs a technological function, it satisfies the requirements of § 101. The statement dismisses any consideration of the preemptive scope of a claim in these circumstances, which thoroughly repudiates the construction given to *Benson* by the Court of Claims. Indeed, this law was undoubtedly self-evident to the Court of Claims, especially for a structure that is already statutory subject matter (cf. par. 20(b)). A given piece of statutory subject matter preempts far more, when claimed in isolation, than it does in combination with an applied mathematical formula or scientific principle.

33. Plaintiff returned to the Court of Claims and, arguing from the Supreme Court's declarations in *Diehr*, moved for an order to: (1) vacate the judgment entered against plaintiff and (2) declare that the '052 claims 2 and 6 are valid under 35 USC § 101. The Court of Claims denied this motion out of hand.

34. Plaintiff's last resort in the '052 patent suit was to file a complaint of judicial misconduct under a newly enacted law: 28 USC § 372(c). The complaint was filed (Nov. 9, 1981) against the adm. judge and all the sitting judges of the Court of Claims. It recounted essentially the same wrongdoing said in this petition. Under the law, ¶ 7(B)(ii) of § 372(c), the Court of Claims should have referred the complaint to the Judicial Conference. Instead, the chief judge of the Court of Claims wrongfully

commissioned a retired senior judge to act on the complaint. However, it mattered little. Both the senior judge and the committee for the Judicial Conference, on appeal, spoke as one mind and dismissed the complaint for being "directly related to the merits of a decision." Of course, the things complained of were indeed "directly related to the merits of a decision," exactly as corruption, perjury, suppression of evidence, false evidence, and false law are so related. The senior judge and the committee for the Judicial Conference chose to disregard these crimes and, in effect, joined the conspiracy of the Court of Claims.

35. Plaintiff now demands judgment:

(1) That plaintiff held valid patent rights under claims 2 and 6 of the '052 patent.

(2) That said patent rights were infringed by ballistic missiles used or manufactured by or for the Government.

(3) That awards just compensation to plaintiff, including delay damages, for all said infringement.

March 26, 1997

George Arshal, *pro se*
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Federal Way, WA 98003
(253) 838–0969

Supreme Court, U.S.
FILED

97 1872 MAY 20 1998

OFFICE OF THE CLERK

No.

The Supreme Court of the United States

OCTOBER TERM, 1997

GEORGE ARSHAL, Petitioner,

v.

JOHN H. DALTON, Secretary of the Navy.

Petition for a Writ of Certiorari to
The United States Court of Appeals
for the Ninth Circuit

APPENDIX 6

George Arshal, *pro se*
124 S. 339th Cir., #C
Federal Way, WA 98003
(253) 838-0969

DIRECTIONAL COMPUTER

Original Filed July 2, 1962 7 Sheets-Sheet 1

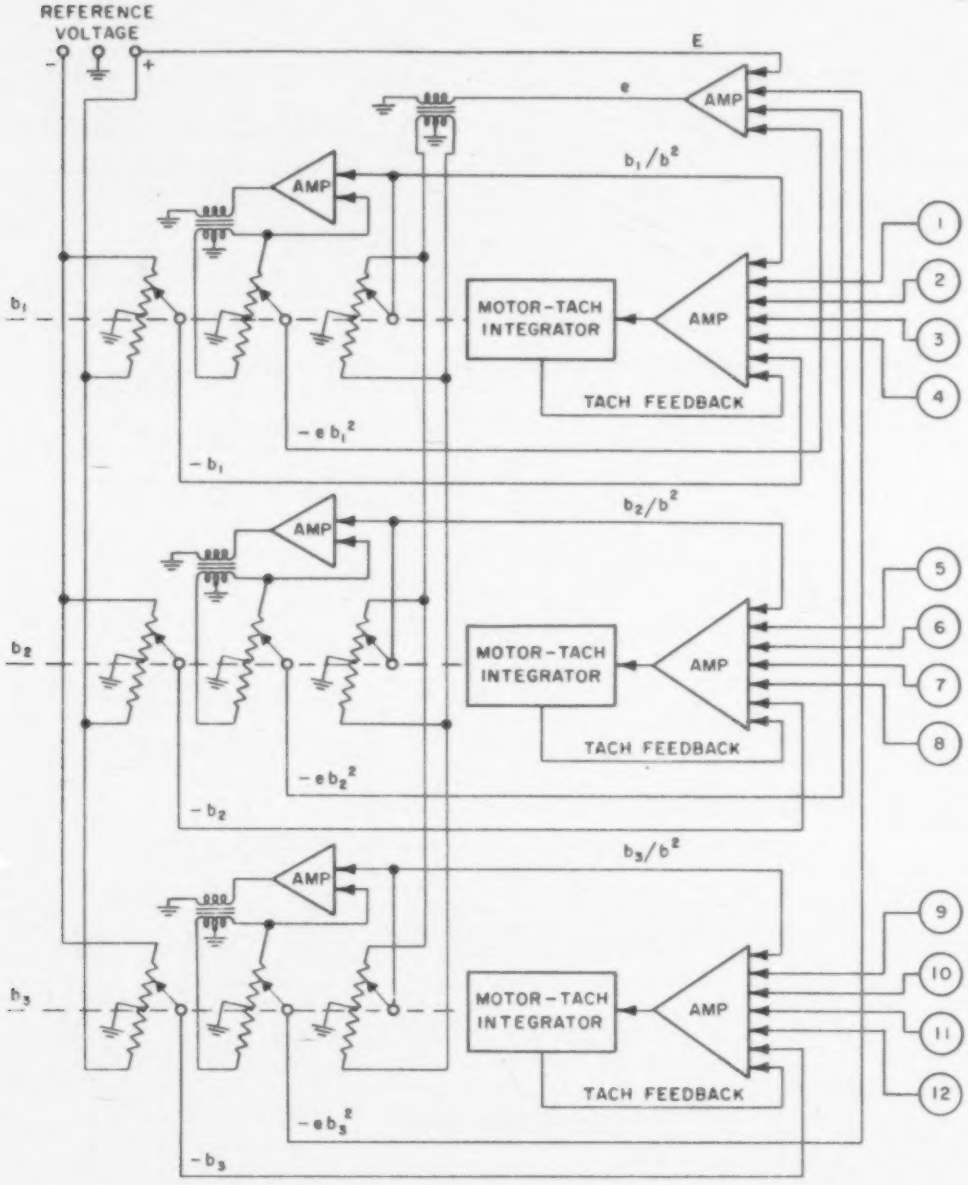

FIG. 1

INVENTOR.

George Arshal

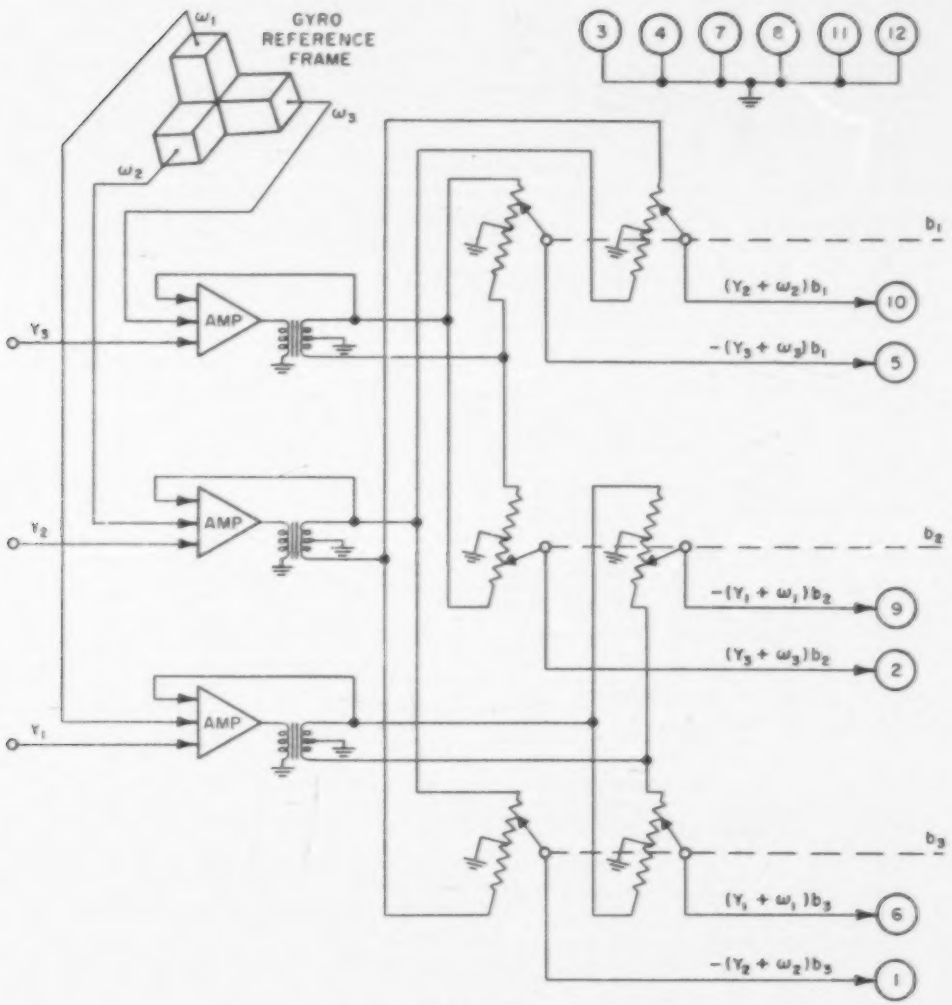

FIG. 1a

INVENTOR.

George Arshal

DIRECTIONAL COMPUTER

Original Filed July 2, 1962 7 Sheets-Sheet 3

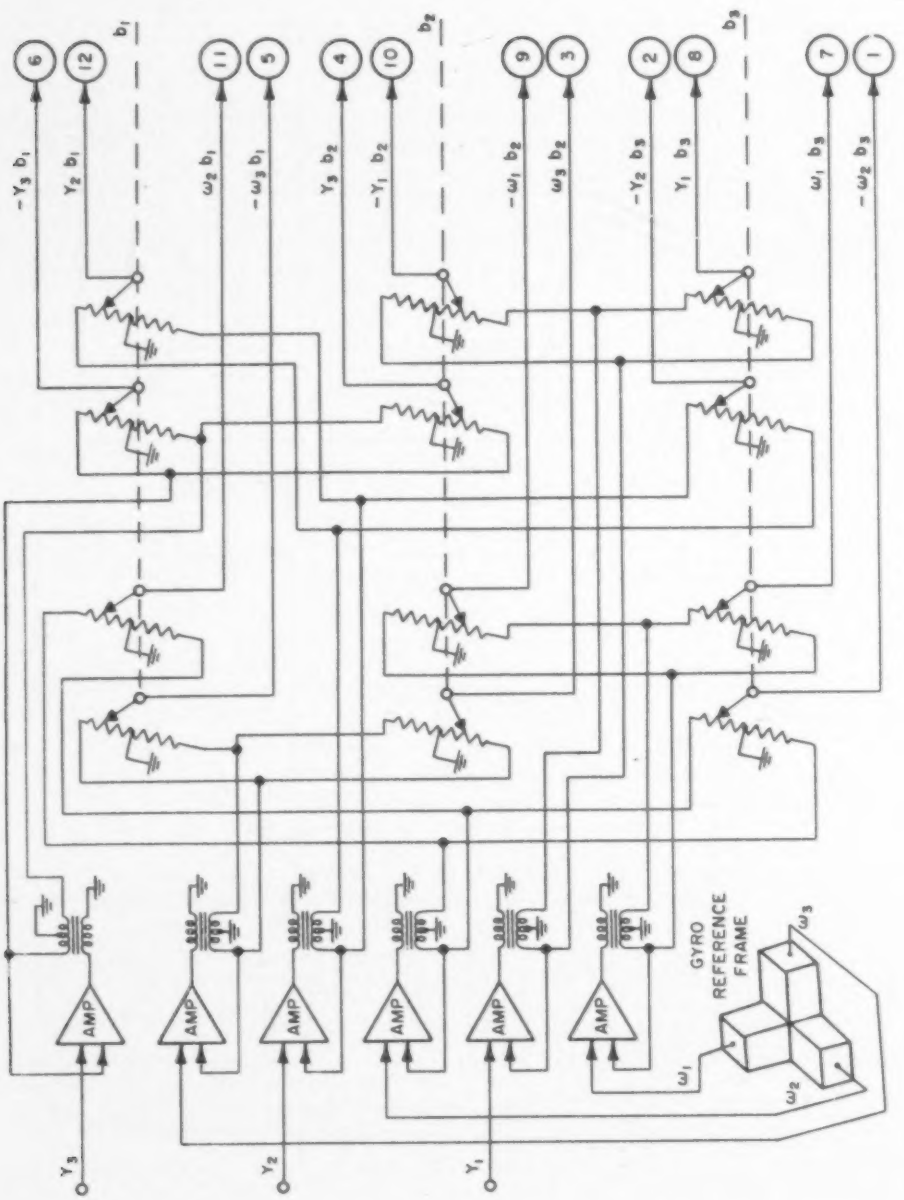

FIG. 1b

INVENTOR.

George Arshal

DIRECTIONAL COMPUTER

Original Filed July 2, 1962 7 Sheets-Sheet 4

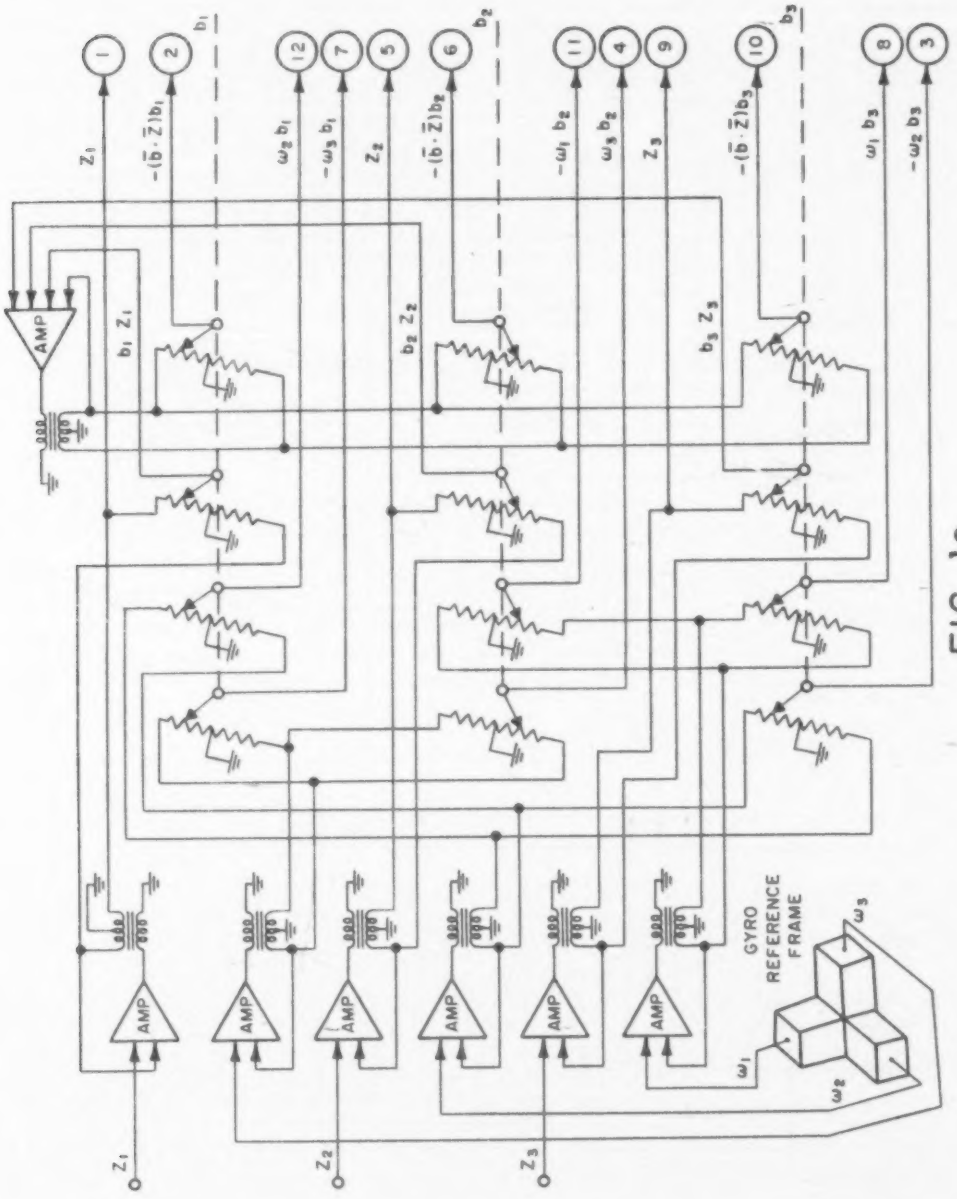

FIG. 1c

INVENTOR.

George Arshal

DIRECTIONAL COMPUTER

Original Filed July 2, 1962 7 Sheets-Sheet 5

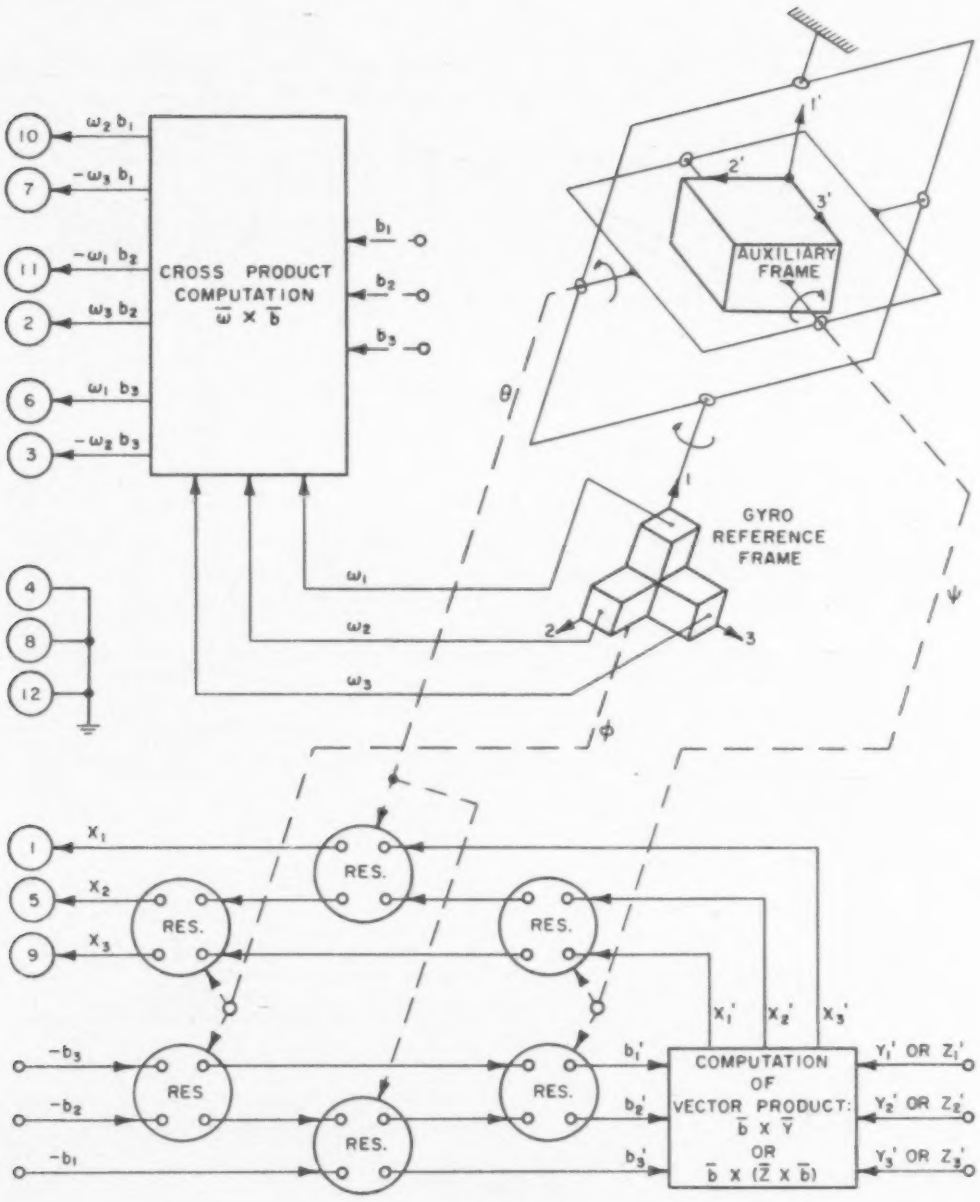

FIG. 1d

INVENTOR.

George Arshal

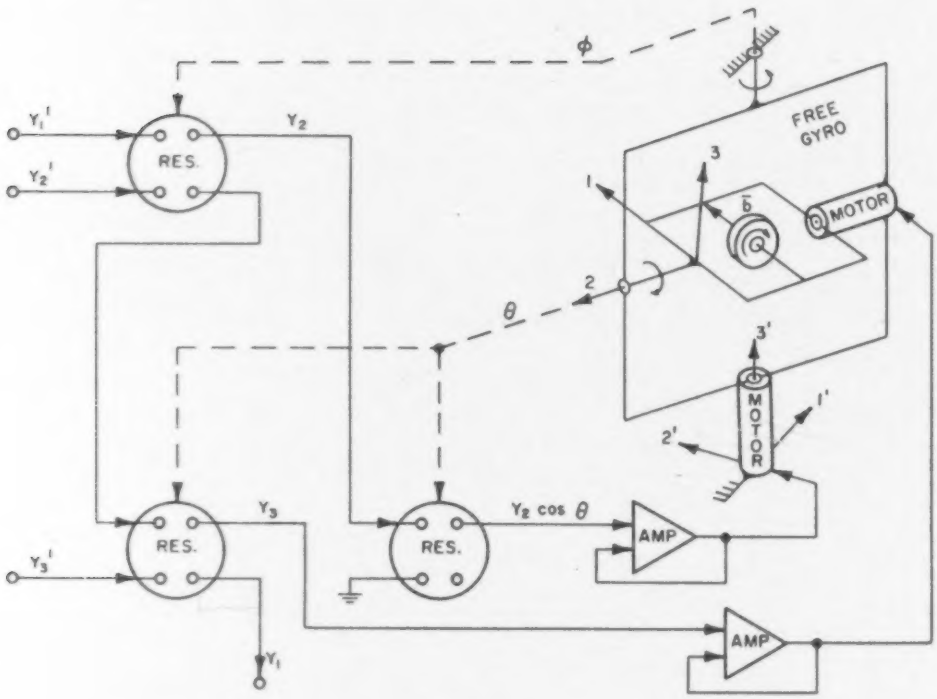

FIG. 2

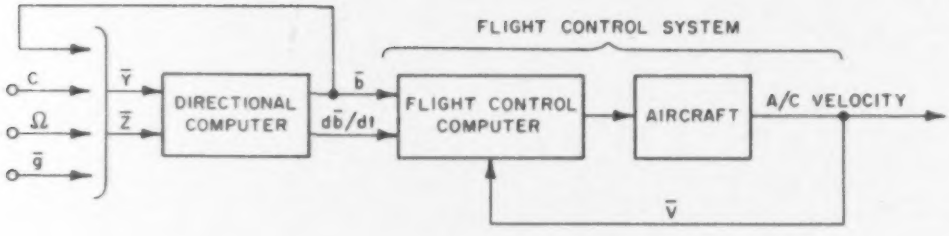

FIG. 3

INVENTOR.

George Arshal

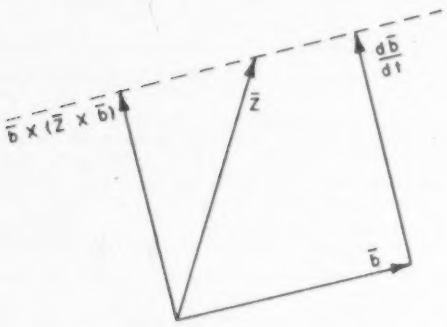

FIG. 4

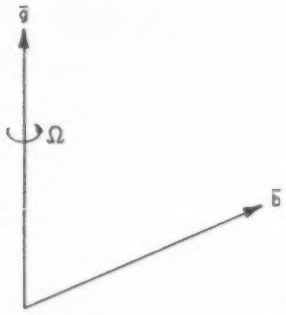

FIG. 5

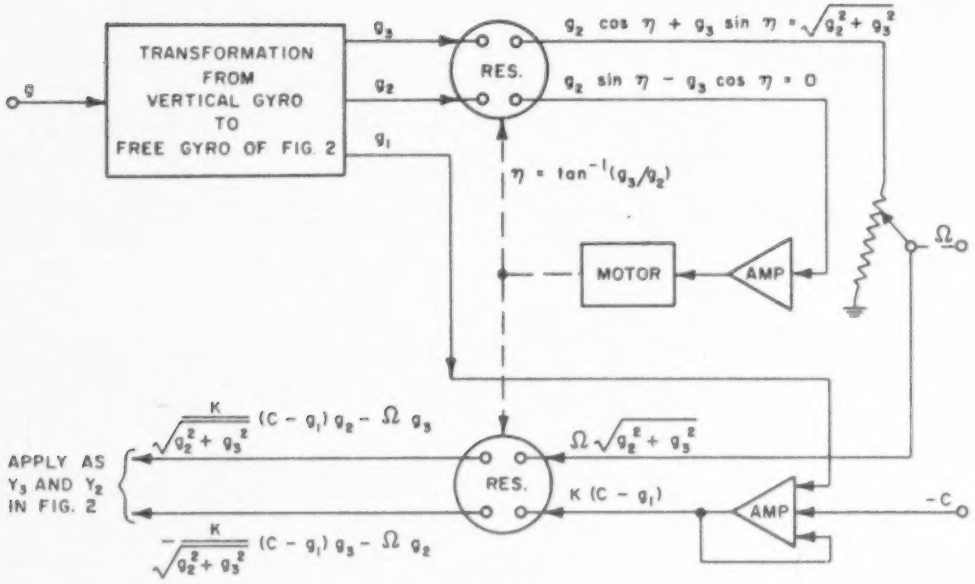

FIG. 6

INVENTOR.

George Arshal

United States Patent Office

3,319,052
Patented May 9, 1967

3,319,052

DIRECTIONAL COMPUTER

George Arshal, 714 Ardmore Ave.,
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Continuation of application Ser. No. 206,801, July 2, 1962. This application Jan. 20, 1966, Ser. No. 533,106
25 Claims. (Cl. 235—150.26)

This application is a continuation of pending patent application No. 206,801 of filing date July 2, 1962, now abandoned.

The invention is a vectorial data processing system for extracting or prescribing directions and their rates of change from given input vectors. It offers efficiency and versatility for producing the direction in satisfaction of any and all geometrical and rate of change properties that are possibly possessed by a direction. While offering this facility, the directional computer can be realized in conjunction with any physically demonstrated frame of reference.

The directional computer proceeds on the principle that a direction changes when it is given an angular velocity. Any input vector can enter the directional computer and assert the angular velocity of the output direction in one or both of two ways:

(1) So that the output direction rotates around the input vector to describe a conical surface.
(2) So that the output direction rotates directly towards the input vector and seeks coalignment.

The rate of action in each case depends on the magnitude of the input vector. The rates are independently controllable by modifying the input vector through distinct scalar coefficients. This holds implications beyond a complete capability of controlling the directional rates of change. The scalar coefficient controlling either mode of directional rate of change can clearly be made zero to stop this process, or it can be made negative to reverse the process. Where it is desired to rotate the output direction around the input vector (mode 1 above) to a particular azimuth, it is only necessary to make the scalar coefficient controlling this rate of turn responsive to the deviation of the output direction from the desired azimuth. In like manner, the scalar coefficient controlling the output direction's rate of turn towards the input vector (mode 2 above) can guide this process into a desired relative angle. The scalar coefficient simply has to register the deviation of the output direction from its desired angle relative to the input vector.

These capabilities of the directional computer support applications exceeding the stabilization functions of one kind or another associated with previous directional output devices. They additionally service demanding applications requiring wide ranging directional controls under a variety of options.

Aircraft flight control offers a case in point. Very effective flight control can be achieved by automatically controlling the aircraft's velocity to a given direction. Thereafter, the direction is solely responsible for guiding the aircraft. The direction must be produced with the versatility of generating any flight path desired.

FIGURE 1 and any one of FIGURES 1*a*, 1*b*, 1*c* and 1*d* together draw an embodiment of the directional computer. FIGURE 2 is another embodiment. FIGURE 3 illustrates an application of the directional computer. FIGURES 4 and 5 are geometrical representations of basic processes supported by the computer. FIGURE 6 illustrates a specifically identified input vector under the embodiment of FIGURE 2.

The directional computer, in all its embodiments, is an implementation of the relationship:

$$\overline{b}=\int\left[\left(\frac{A}{b^2}-B\right)\overline{b}+\overline{b}\times\overline{\Upsilon}\right]dt \tag{1}$$

where $\overline{b}$ represents the directional output vector; $\overline{\Upsilon}$ represents any given vector or the result of a combination of vectors; A and B represent scalar constants. Under this formulation, $\overline{b}$ is maintained at a constant length, having therefore a purely directional significance, and its direction is controlled with complete versatility by the choice of $\overline{\Upsilon}$.

These events are understood from the derivative form of (1):

$$\frac{d\overline{b}}{dt}=\left(\frac{A}{b^2}-B\right)\overline{b}+\overline{b}\times\overline{\Upsilon} \tag{2}$$

If (2) is multiplied out scalarly by $\overline{b}\cdot$, the relationship establishing its magnitude is isolated as

$$\overline{b}\cdot\frac{d\overline{b}}{dt}=\frac{1}{2}\frac{d}{dt}(b^2)=A-Bb^2 \tag{3}$$

This is a linear, first order differential equation in b^2. Under this relationship, b^2 soon assumes the value A/B and then holds it indefinitely. Thereafter, relation (2) is represented in its essential characteristics by:

$$\frac{d\overline{b}}{dt}=\overline{b}\times\overline{\Upsilon} \tag{4}$$

since this relation does not disturb the magnitude of $\overline{b}$. If (4) is multiplied vectorially by

$$\frac{\overline{b}}{b^2}\times$$

its action is described in full by:

$$\frac{\overline{b}}{b^2}\times\frac{d\overline{b}}{dt}=-\frac{\overline{b}}{b}\times\left(\overline{\Upsilon}\times\frac{\overline{b}}{b}\right) \tag{5}$$

The left side of (5) is identically equal to the angular velocity of $\overline{b}$ and the right side of (5) produces it as the portion of $-\overline{\Upsilon}$ that is perpendicular to $\overline{b}$.

Since the input vector $\overline{\Upsilon}$ is open to choice, it can be stated as:

$$\overline{\Upsilon}=\overline{Z}\times\overline{b} \tag{6}$$

where $\overline{Z}$ is a given vector. Then relation (1) becomes:

$$\overline{b}=\int\left[\left(\frac{A}{b^2}-B\right)\overline{b}+\overline{b}\times(\overline{Z}\times\overline{b})\right]dt \tag{7}$$

and has the alternative form:

$$\overline{b}=\int\left[\left(\frac{A}{b^2}-B\right)\overline{b}+b^2\overline{Z}-(\overline{b}\cdot\overline{z})\overline{b}\right]dt \tag{8}$$

This follows from the "continued vector product" formula. The coefficient b^2 multiplying $\overline{Z}$ in (8) can be replaced by the value A/B given to it by relation (3). That is, the input (6) can be asserted in relation (1) as:

$$\frac{A}{B}\overline{Z}-(\overline{b}\cdot\overline{Z})\overline{b}=\overline{b}\times\overline{\Upsilon} \tag{9}$$

The result of this substitution and relation (7) are functionally the same.

Relation (7) possesses a basic computational capability. Under the input and feedback carried in $\overline{b}\times(\overline{Z}\times\overline{b})$, the direction $\overline{b}$ is driven into coincidence with the direction of $\overline{Z}$. The magnitude of $\overline{Z}$ is immaterial to the process so long as it is scaled up by a substantial gain factor. The fact that the input $\overline{Z}$ can be scaled arbitrarily in the proc-

$$b_3=\int\left[\left(\frac{A}{b^2}-B\right)b_3-\omega_1 b_2+\omega_2 b_1+X_3\right]dt \quad (27)$$

Relations (19) can be satisfied in other ways. The possibility of constraining the reference frame into zero components of angular velocity or of utilizing a reference frame possessing those properties to begin with has already been cited. The affected product terms accordingly drop out of relations (19). Another possibility is to produce the output vector $\overline{b}$ under the constraint that:

$$b_2=b_3=0 \quad (28)$$

Then the relations (19) become:

$$b_1=b=\int\left(\frac{A}{b^3}-B\right)bdt \quad (29)$$

$$0=Y_2+\omega_3 \quad (30)$$

$$0=Y_3+\omega_2 \quad (31)$$

and the output $\overline{b}$ belongs to the **1** axis alone. Under this reduction, relation (29) can be dispensed with. Its function is to fix the magnitude b. But, in being a single component, the magnitude b can be assigned any constant value at once. Moreover, relations (30) and (31) are indifferent to this constant. The constant is necessary only in a process of transforming the vector $\overline{b}$ into another reference frame and in scaling Y_2 and Y_3 to express $d\overline{b}/dt$. In the absence of an expressed constant, Y_3 and Y_2 express $d\overline{b}/dt$ with the implication that b is unity.

Relations (30) and (31) assert a requirement for specific control over the angular velocity components of the reference frame about the two axes perpendicular to the reference axis expressing $\overline{b}$. Hence, this reference frame **1**, **2**, **3** is serving as a specialized computing element, and the input vector $\overline{Y}$ invariably originates in a separate and distinct frame of reference. The components Y_2 and Y_3 have to be developed under a coordinate transformation. The coordinate transformation is subsequently affected by its own component outputs and is a functional participant in this process of establishing relations (19).

FIGURE 2 illustrates the situation. The vector $\overline{Y}$ passes to the gyro reference frame **1**, **2**, **3** from the supporting frame of reference **1'**, **2'**, **3'**. The transformation proceeds as:

$$\begin{aligned} W&=Y_2'\cos\phi+Y_1'\cos\phi \\ Y_2&=Y_2'\cos\phi-Y_1'\sin\phi \\ Y_1&=Y_3'\sin\theta+W\cos\theta \\ Y_3&=Y_3'\cos\theta-W\sin\theta \end{aligned} \quad (32)$$

Thereafter, the gyro reference frame is driven with the angular rates $-Y_2$ and $-Y_3$ about its **2** and **3** axes. This in turn affects the angles θ and ϕ.

The input vector $\overline{Y}$ is asserted as $\overline{Z}\times\overline{b}$ in relations (30) and (31) when the substitutions (21) are applied with recognition of the conditions (28), so that:

$$\frac{A}{B}Z_2=-Y_3b$$

$$\frac{A}{B}Z_3=Y_2b \quad (33)$$

But A/B is just b^2 and b is an arbitrary scale constant. In effect, the substitutions (21) enter relations (30) and (31) as:

$$\begin{aligned} 0&=-Z_2+\omega_3 \\ 0&=Z_3+\omega_2 \end{aligned} \quad (34)$$

The components Z_2 and Z_3 come into the gyro reference frame through a coordinate transformation of the input vector $\overline{Z}$ that is just like the transformation of $\overline{Y}$.

The figures present some varied embodiments of the directional computer. FIGURE 1 and any one of FIGURES 1*a*, 1*b*, and 1*c* illustrate examples from relations (19) to (22). FIGURES 1 and 1*d* illustrate the example of relations (23) to (27). FIGURE 2 illustrates the example of relations (30), (31), and (32) and the like example of relations (32) and (34). FIGURE 6 illustrates a manner of forming the input vector (15) for incorporation in FIGURE 2.

The electro-mechanical integrators in FIGURE 1 produce their rotational outputs as signals b_1, b_2, and b_3. These integral outputs each position a number of linear potentiometers to yield products of multiplication. The first two potentiometers (from right to left, FIGURE 1) on each shaft are series connected through feedback amplifiers and are energized by a common transformer output e to give the signals $-eb_1^2$, $-eb_2^2$, and $-eb_3^2$ as their end outputs. These three outputs all feed back, together with a reference voltage input E, into the amplifier that produces e. Through the high gain of the amplifier, the finite output e is produced under the condition:

$$E-eb_1^2-eb_2^2-eb_3^2\sim 0$$

Therefore,

$$e\approx\frac{E}{b_1^2+b_2^2+b_3^2}=\frac{E}{b^2}$$

and the first stage outputs from the series connected potentiometers are signals proportional to b_1/b^2, b_2/b^2, and b_3/b^2. These signals are delivered to the amplifier input stage of their respective integrators in accord with relations (19). The same applies to the signals $-b_1$, $-b_2$, and $-b_3$ that are tapped from the remaining three potentiometers of FIGURE 1. The signals scale to the desired coefficients A and B of relations (19) through the values to input summing resistors contained in the amplifiers. The further electrical signals that are delivered to the integrators are identified by the numerals **1** to **12** shown both in FIGURE 1 and in any one of the FIGURES 1*a*, 1*b*, 1*c*, and 1*d*.

In FIGURE 1*a*, six more potentiometers are positioned by the three shaft rotations b_1, b_2, and b_3. The potentiometers are energized by the signals $\pm(\omega_1+Y_1)$, $\pm(\omega_2+Y_2)$, and $\pm(\omega_3+Y_3)$ that are so combined in feedback amplifiers. The six products of multiplication return as inputs to the integrators of FIGURE 1 in accordance with relations (19). Only six of the twelve electrical return lines are utilized.

FIGURE 1*b* is functionally the equivalent of FIGURE 1*a*. Twelve rather than six potentiometer multiplications by b_1, b_2, and b_3 are generated under separate energizing by $\pm\omega_1$, $\pm\omega_2$, $\pm\omega_3$ and $\pm Y_1$, $\pm Y_2$, $\pm Y_3$. The products are all properly fed back and summed at the integrators of FIGURE 1. The separate development of the products in $b_{1,2,3}$ and $Y_{2,3,1}$ allows the components of $\overline{b}\times\overline{Y}$ to be formed to give $d\overline{b}/dt$.

FIGURE 1*c* repeats FIGURE 1*b* in its manner of producing the six products in $\omega_{1,2,3}$ and $b_{2,3,1}$ and applying them at the integrators of FIGURE 1. Thereafter, FIGURE 1*c* develops the substitutions asserted by relations (21) and (22). The signals Z_1, Z_2, Z_3 successively energize three potentiometers on the shaft outputs b_1, b_2, and b_3. The three products formed are submitted to a feedback amplifier for summation as the output

$$-\overline{b}\cdot\overline{Z}=-(b_1Z_1+b_2Z_2+b_3Z_3)$$

This output is applied to three more potentiometers to generate the products $-(\overline{b}\cdot\overline{Z})b_1$, $-(\overline{b}\cdot\overline{Z})b_2$, and $-(\overline{b}\cdot\overline{Z})b_3$. These product signals and the signals Z_1, Z_2, and Z_3 enter the integrators of FIGURE 1 in accord with relations (21) and (19).

In FIGURE 1*d*, the vector product $\overline{b}\times\overline{Y}$ or $\overline{b}\times(\overline{Z}\times\overline{b})$ is developed in an auxiliary frame of reference directions **1'**, **2'**, **3'** wherein the vector $\overline{Y}$ or $\overline{Z}$ is expressed by the signals Y_1', Y_2', Y_3' or Z_1', Z_2', Z_3'. The signals $-b_1$,

$-b_2$, and $-b_3$ come from FIGURE 1. Three resolvers, each capable of performing the computations:

$$\left.\begin{array}{l}\pm(x \sin a + y \cos a)\\ \pm(x \cos a - y \sin a)\end{array}\right\} a = \text{any angle}$$

on inputs x and y in any desired pairing of + and/or − signs, apply the transformation (23) and reproduce the output direction $\bar{b}$ as component signals b_1', b_2', b_3' referred to the auxiliary reference frame. Three positioning servos can subsequently reproduce the signals b_1', b_2', and b_3' as equivalent shaft rotations and the vector product computations (24) can proceed in the manner represented in FIGURES 1*b* and 1*c*. The signal summations noted as X_1', X_2', X_3' in relations (24) form at the input terminals of three more resolvers performing the inverse transformation (26). The vector product is thus produced as signals X_1, X_2, X_3 referring to the gyro reference directions **1**, **2**, **3**. X_1, X_2, and X_3 enter the integrators of FIGURE 1 in accordance with relations (27). The cross product signals $\overset{in}{\omega}_{1,2,3}$ and $b_{2,3,1}$ also enter the integrators of FIGURE 1 in accordance with relations (27), their formation being processed in the manner represented in FIGURES 1*b* and 1*c*.

In any of the foregoing embodiments, the product formations in ω_1, ω_2, ω_3 and b_1, b_2, b_3 are eliminated in whole or in part by the special circumstance that the reference frame is stabilized so that one or more of its component angular velocities is zero. If, also, by the nature of the input vector in the particular reference frame utilized, one or two of the input vector components are consistently zero, all the computations regarding them in that reference frame go out.

FIGURE 2 shows an embodiment applying a controllable reference frame as furnished by a free gyro. The gyro spin axis, the inner gimbal axis, and their mutually perpendicular direction provide the reference directions **1**, **2**, and **3** respectively, the spin axis **1** being the output direction. The structure mounting the gyro defines the auxiliary reference directions **1'**, **2'**, **3'**. Two resolvers receiving the input vector $\bar{Y}$ as components Y_1', Y_2', Y_3' in the auxiliary frame of reference perform the transformation (32) to reproduce $\bar{Y}$ by its components Y_1, Y_2, Y_3 in the gyro reference frame. The component Y_1 is superfluous, however. The necessary components are Y_2 and Y_3. Y_2 and Y_3 must satisfy relations (30) and (31) by driving the gyro reference frame into component angular velocities that are in equal and opposite proportions to themselves. For this reason, Y_2 is first diminished through a resolver by the multiplying factor $\cos\theta$. Then Y_2' $\cos\theta$ and Y_3 are amplified to precise power levels and energize linear torquemotors acting on the gyro about the **3'** and **2** axes. Y_3, driving through the **2** axis, rotates the gyro about the **3** axis at a directly proportional rate. Y_2 $\cos\theta$, driving through **3'**, is offset by angle θ from the gyro's **3** axis. While causing the gyro to rotate about the **2** axis, Y_2 $\cos\theta$ induces a reaction torque normal to the pivotal axes of the outer gimbal. This reaction torque and the applied torque about **3'** give their resultant about the **3** axis and act together to rotate the gyro. The resultant exceeds the applied torque by the factor $\sec\theta$. But Y_2 has been reciprocally attenuated so that the gyro rotates about its **2** axis at a rate directly proportional to Y_2.

The relations (34) are produced instead of (30) and (31) in FIGURE 2 when Y_2 and Y_3 are identified as Z_2 and Z_3 and their roles in rotating the gyro reference frame are interchanged. In either case, the rotational rates must have the functionally correct sense and the torquemotor input connections must observe proper electrical polarities.

FIGURE 6 illustrates the facility with which the directional computer accommodates various, purposeful

input vectors. In this example, the input vector of FIGURE 2 is developed as the quantity (15).

By FIGURE 6, the two left-most resolvers in FIGURE 2 are consigned to a transformation between a vertical gyro and the free gyro. This transformation refers a signal g to a physically demonstrated vertical direction and resolves it in stages into the free gyro frame of reference. Thereafter, the component outputs g_3, g_2, and g_1 are submitted to additional computations that modify them into components conforming to the vector quantity (15). These components are developed for the **2** and **3** axes and drive the free gyro in just the manner illustrated with Y_2 and Y_3 in FIGURE 2.

The upper resolver in FIGURE 6 is rotated under the feedback of one of its outputs and acquires the angle η that produces its other output as the resultant of the inputs g_2 and g_3. The same angle η positions the lower resolver. The indicated input and output relationships for the lower resolver are self-evident under the relationships

$$\sin\eta = \frac{g_3}{\sqrt{g_2^2 + g_3^2}}$$

and

$$\cos\eta = \frac{g_2}{\sqrt{g_2^2 + g_3^2}}$$

that have been established. The outputs obtained apply as the components of the vector quantity (15) in the **3** and **2** axes (FIGURE 2) since $\bar{g}\cdot\bar{b} = g_1$ in this embodiment and the gain factor K_1 is allowed to vary as

$$K_1 = \frac{K}{\sqrt{g_2^2 + g_3^2}}$$

The inventor claims:

1. A directional computer comprising a physically defined reference frame, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, means of generating a plurality of signals describing the angular motion of said reference frame in space, said signals of angular motion indicating the angular velocity vector of said reference frame, and means to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of the cross product vectors between the said output vector and the said angular velocity vector and between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

2. A directional computer comprising a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, and means to receive the said input signals and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of the cross product vector between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

3. A directional computer comprising a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity, the axes of said reference frame being denoted by the numerals **1**, **2**, **3**, means of obtaining an input signal in representation of any desired value, said input signal being referred to said axis **3** to express an input vector, and means to receive the said input signal and generate a pair of output signals expressing an output vector in reference to the said axes **1** and **2** as the integral of the cross product vector between the said output vector and the said

input vector, whereby the said output vector is driven by the said input signal to rotate around the said axis 3.

4. A directional computer comprising a physically defined first reference frame and a second reference frame defined with respect to the said first frame by means to perform a coordinate transformation therebetween, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said second reference frame to express an input vector, means of generating a plurality of signals describing the angular motion of said first reference frame in space, said signals of angular motion indicating the angular velocity vector of said first reference frame, and means, including said coordinate transformation means, to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said first reference frame as the integral of the cross product vectors between the said output vector and the said angular velocity vector and between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

5. A directional computer comprising a physically defined first reference frame and a second reference frame defined with respect to the said first frame by means to perform a coordinate transformation therebetween, means of obtaining an input signal in representation of any desired value, said input signal being referred to an axis of said second reference frame to express an input vector, means of generating a plurality of signals describing the angular motion of said first reference frame in space, said signals of angular motion indicating the angular velocity vector of said first reference frame, and means, including said coordinate transformation means, to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said first reference frame as the integral of the cross product vectors between the said output vector and the said angular velocity vector and between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

6. A directional computer comprising a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity, a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said second reference frame to express an input vector, and means, including said coordinate transformation means, to receive the said input signals and generate a plurality of output signals expressing an output vector in relation to said stabilized reference frame as the integral of the cross product vector between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

7. A directional computer comprising a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity, a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween, means of obtaining an input signal in representation of any desired value, said input signal being referred to an axis of said second reference frame to express an input vector, and means, including said coordinate transformation means, to receive the said input signal and generate a plurality of output signals expressing an output vector in relation to said stabilized reference frame as the integral of the cross product vector between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

8. A directional computer comprising a physically defined reference frame, mens of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, means of generating a plurality of signals describing the angular motion of said reference frame in space, said signals of angular motion indicating the angular velocity vector of said reference frame, and means to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of a vector quantity consisting of the said input vector, the negative value of the said output vector multiplied by the scalar product between the said input and output vectors, and the cross product vector between the said output vector and the said angular velocity vector, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

9. A directional computer comprising a physically defined, stabilized reference frame, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, and means to receive the said input signals and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of a vector quantity consisting of the said input vector and the negative value of the said output vector multiplied by the scalar product between the said input and output vectors, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

10. A directional computer comprising a physically defined, stabilized reference frame, means of obtaining an input signal in representation of any desired value, said input signal being referred to an axis of said reference frame to express an input vector, and means to receive the said input signal and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of a vector quantity consisting of the said input vector and the negative value of the said output vector multiplied by the scalar product between the said input and output vectors, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

11. A directional computer comprising a physically defined first reference frame and a second reference frame defined with respect to the said first frame by means to perform a coordinate transformation therebetween, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said second reference frame to express an input vector, means of generating a plurality of signals describing the angular motion of said first reference frame in space, said signals of angular motion indicating the angular velocity vector of said first reference frame, and means, including said coordinate transformation means, to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said first reference frame as the integral of a vector quantity consisting of the said input vector, the negative value of the said output vector multiplied by the scalar product between the said input and output vectors, and the cross product vector between the said output vector and the said angular velocity vector, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

12. A directional computer comprising a physically defined first reference frame and a second reference frame defined with respect to the said first frame by means to perform a coordinate transformation therebetween, means of obtaining an input signal in representation of any desired value, said input signal being referred to an axis of said second reference frame to express an input vector,

means of generating a plurality of signals describing the angular motion of said first reference frame in space, said signals of angular motion indicating the angular velocity vector of said first reference frame, and means, including said coordinate transformation means, to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said first reference frame as the integral of a vector quantity consisting of the said input vector, the negative value of the said output vector multiplied by the scaler product between the said input and output vectors, and the cross product vector between the said output vector and the said angular velocity vector, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

13. A directional computer comprising a physically defined, stabilized reference frame and a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said second reference frame to express an input vector, and means, including said coordinate transformation means, to receive the said input signals and generate a plurality of output signals expressing an output vector in relation to said stabilized reference frame as the integral of a vector quantity consisting of the said input vector and the negative value of the said output vector multiplied by the scalar product between the said input and output vectors, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

14. A directional computer comprising a physically defined, stabilized reference frame and a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween, means of obtaining an input signal in representation of any desired value, said input signal being referred to an axis of said second reference frame to express an input vector, and means, including said coordinate transformation means, to receive the said input signal and generate a plurality of output signals expressing an output vector in relation to said stabilized reference frame as the integral of a vector quantity consisting of the said input vector and the negative value of the said output vector multiplied by the scalar product between the said input and output vectors, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

15. A directional computer comprising a physically defined, stabilized reference frame and a separate reference axis defined with respect to the said stabilized frame by means to perform coordinate resolutions therebetween, means of obtaining an input signal in representation of any desired value, said input signal being referred to said separate axis to express an input vector, and means, including said coordinate resolution means, to receive the said input signal and generate a plurality of output signals expressing an output vector in relation to said stabilized reference frame as the integral of a vector quantity consisting of the said input vector and the negative value of the said output vector multiplied by the scalar product between the said input and output vectors, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

16. A directional computer comprising a physically defined reference frame and a separate reference axis defined with respect to the said reference frame by means to perform coordinate resolutions therebetween, means of obtaining an input signal in representation of any desired value, said input signal being referred to said separate axis to express an input vector, means of generating a plurality of signals describing the angular motion of said reference frame in space, said signals of angular

motion indicating the angular velocity vector of said reference frame, and means, including said coordinate resolution means, to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of a vector quantity consisting of the said input vector, the negative value of the said output vector multiplied by the scalar product between the said input and output vectors, and the cross product vector between the said output vector and the said angular velocity vector, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

17. A directional computer comprising means of generating a plurality of signals describing the angular motion of a physical reference frame in space, said reference frame being defined by the said means, said signals of angular motion indicating the angular velocity vector of said reference frame, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, and means to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of the cross product vectors between the said output vector and the said angular velocity vector and between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

18. A directional computer comprising means of generating a plurality of signals describing the angular motion of a physical reference frame in space, said reference frame being defined by the said means, said signals of angular motion indicating the angular velocity vector of said reference frame, a second reference frame defined with respect to the said physical frame by means to perform a coordinate transformation therebetween, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said second reference frame to express an input vector, and means, including said coordinate transformation means, to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said physical reference frame as the integral of the cross product vectors between the said output vector and the said angular velocity vector and between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

19. A directional computer comprising, means of generating a plurality of signals describing the angular motion of a physical reference frame in space, said reference frame being defined by the said means, said signals of angular motion indicating the angular velocity vector of said reference frame, a second reference frame defined with respect to the said physical frame by means to perform a coordinate transformation therebetween, means of obtaining an input signal in representation of any desired value, said input signal being referred to an axis of said second reference frame to express an input vector, and means, including said coordinate transformation means, to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said physical reference frame as the integral of the cross product vectors between the said output vector and the said angular velocity vector and between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

20. A directional computer comprising means of generating a plurality of signals describing the angular motion of a physical reference frame in space, said reference frame being defined by the said means, said signals of angular motion indicating the angular velocity vector of said reference frame, means of obtaining a plurality of input

signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, and means to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of a vector quantity consisting of the said input vector, the negative value of the said output vector multiplied by the scalar product between the said input and output vectors, and the cross product vector between the said output vector and the said angular velocity vector, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

21. A directional computer comprising means of generating a plurality of signals describing the angular motion of a physical reference frame in space, said reference frame being defined by the said means, said signals of angular motion indicating the angular velocity vector of said reference frame, a second reference frame defined with respect to the said physical frame by means to perform a coordinate transformation therebetween, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said second reference frame to express an input vector, and means, including said coordinate transformation means, to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said physical reference frame as the integral of a vector quantity consisting of the said input vector, the negative value of the said output vector multiplied by the scalar product between the said input and output vectors, and the cross product vector between the said output vector and the said angular velocity vector, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

22. A directional computer comprising means of generating a plurality of signals describing the angular motion of a physical reference frame in space, said reference frame being defined by the said means, said signals of angular motion indicating the angular velocity vector of said reference frame, a second reference frame defined with respect to the said physical reference frame by means to perform a coordinate transformation therebetween, means of obtaining an input signal in representation of any desired value, said input signal being referred to an axis of said second reference frame to express an input vector, and means, including said coordinate transformation means, to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said physical reference frame as the integral of a vector quantity consisting of the said input vector, the negative value of the said output vector multiplied by the scalar product between the said input and output vectors, and the cross product vector between the said output vector and the said angular velocity vector, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

23. A directional computer comprising means of generating a plurality of signals describing the angular motion of a physical reference frame in space, said reference frame being defined by the said means, said signals of angular motion indicating the angular velocity vector of said reference frame, a separate reference axis defined with respect to the said reference frame by means to perform coordinate resolutions therebetween, means of obtaining an input signal in representation of any desired value, said input signal being referred to said separate axis to express an input vector, and means, including said coordinate resolution means, to receive the said input and angular motion signals and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of a vector quantity consisting of the said input vector, the negative value of the said output vector multiplied by the scalar product between the said input and output vectors, and the cross product vector between the said output vector and the said angular velocity vector, whereby the said output vector rotates around a direction perpendicular both to the said output vector and the said input vector.

24. A directional computer comprising a physically defined reference frame adapted to rotate about two of its axes, means of receiving angular rate signals and generating corresponding rotations of said reference frame relative to space about said rotational axes, means responsive to said rotations to produce coordinate resolutions between the said rotational axes and the axes of a second reference frame, whereby said second reference frame is defined with respect to the said rotational axes, and means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said second reference frame to express an input vector, the said coordinate resolutions being applied to the said input signals to produce transformed signals expressing the two components of the said input vector relating to the said rotational axes, the said transformed signals forming the said angular rate signals, whereby the direction perpendicular to the said rotational axes in said physically defined reference frame is caused to rotate in a known way with respect to the said input vector.

25. A directional computer comprising a physically defined reference frame adapted to rotate about two of its axes, means of receiving angular rate signals and generating corresponding rotations of said reference frame relative to space about said rotational axes, means responsive to said rotations to produce coordinate resolutions between the said rotational axes and a separate reference axis, whereby said separate axis is defined with respect to the said rotational axes, and means of obtaining an input signal in representation of any desired value, said input signal being referred to said separate axis to express an input vector, the said coordinate resolutions being applied to the said input signal to produce transformed signals expressing the two components of the said input vector relating to the said rotational axes, the said transformed signals forming the said angular rate signals, whereby the direction perpendicular to the said rotational axes in said physically defined reference frame is caused to rotate in a known way with respect to the said input vector.

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